FARES STRUCTURE ANALYSIS

DEMONSTRATION STUDY

Requisition No. G50302A

UMTA GRANT IL-08-0081

UWP #4325.34

Submitted to:

Chicago Transit Authority

Chicago, Illinois

Submitted by:

LTI CONSULTANTS, INC.

ERWIN A. FRANCE & ASSOCIATES

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16. Abstract

This study was concerned with the evaluation of alternative fare structures which were formulated as alternatives to the existing flat fare charged for CTA bus and rail services. This evaluation required the costs and ridership changes associated with each fare structure to be estimated. Ridership changes were estimated on the basis of a demand model which was formulated based on existing market data and fares elasticities derived from Stated Preference surveys of CTA users and non-users. Costs of each option were estimated with the assistance of CTA staff. The evaluation was carried out within a framework which allowed a range of CTA fares policy and goals to be taken into account.

This report is contained in two volumes: Volume I describes the work carried out during the course of the whole study. Volume II is concerned only with the Stated Preference survey work and includes a description of the planning, design, implementation and analysis of the survey data.

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Appendix continued...

EXECUTIVE SUMMARY

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This report is the culmination of the Fares Structure Analysis Demonstration Study carried out by LTI Consultants, Inc., in association with E.A. France and Associates for the Chicago Transit Authority.

- o The project was funded by a grant from the Urban Mass Transportation Administration.

- o The report provides a description of the study work and the conclusions reached.

- o The report is presented in two volumes as follows:

  1. VOLUME I - OPTION EVALUATION

  2. VOLUME II - SURVEY REPORT

Each volume is intended to be free-standing and able to be read independently of its companion volume.

- o Volume I provides a description of the whole study process - the aims, approach, results and conclusions.

- o Volume II provides a detailed description of the survey work - its aims, method and data analysis.

This Executive Summary covers each volume separately; Sections I to X in Volume I and Sections I to VI of Volume II.

VOLUME I

I. BACKGROUND AND INTRODUCTION

The study extended over thirteen months starting in January, 1987. There were three main phases of work:

- Study inception and method formulation;
- Data collection and analysis; option development and costing; formulation of evaluation framework
- Option evaluation and conclusions.

II. STUDY AIMS AND TERMS OF REFERENCE

The aim of the study was to formulate and evaluate a range of medium to long term fare structures which could be implemented by the CTA.

- The method required the establishment of a framework within which options could be evaluated against a range of criteria.

III. AIMS OF THE CTA FARE POLICY

Discussions were held with staff and board members to explore the fare policy goals being pursued by the CTA.

- Areas in which these goals conflict were identified and how the necessary strategic trade-offs between goals could be made were established.

IV. DEVELOPMENT OF EVALUATION FRAMEWORK

The aims of the CTA's fares policy were summarized under ten criteria which were included within an evaluation framework.

- o This allows the priorities assigned by key decision-makers to each criterion to be varied to demonstrate the effect on relative option value.

V. DEFINITION AND ANALYSIS OF CTA'S MARKETS

The market for CTA's services was quantified in terms of size and competitive position against alternative modes of transport.

- o Market segments were determined and levels of sensitivity to fare change established.
- o The segments adopted were:
  - Work versus non-work,
  - Central Area versus Non-Central Area,and
  - Distance.

VI. OPTION DEVELOPMENT

Six options were formulated to represent different methods of charging fares.

- o The options were based on the market segments identified and practical methods of charging fares.
- o The options were:

  1. Peak/off-peak fares

  2(a) Rail zonal fares

  2(b) System zonal fares

  2(c) Rail graduated fares

3. Bus/rail differential fares

4. Maximum prepayment.

These options were designed to address each fare payment method separately; they were not necessarily fully developed in terms of optimizing goal achievement.

VII. OPTION COSTING

Each option was costed in terms of the necessary capital investment for fare equipment and the operating and maintenance costs.

- Costs were based on the necessary changes from the existing system.
- Cost estimates were developed to a level of reliability consistent with the fare revenue estimates.
  - Those options worthy of further development were identified.
- The cost estimates show that the distance-based options would cost considerably more than the others evaluated.
  - The operating and annualized capital cost of distance-based options ranged between $5.8 and $8.6 million per year.
  - The operating and annualized capital cost of the other options ranged between $0.08 and $1.3 million per year.

VIII. DATA SOURCES

A demand model was formulated to estimate the ridership and revenue effects of each option, based on existing data and new data collected through stated preference surveys carried out by E.A. France and Associates.

- Existing data sources - the 1980 Census, 1979 Origin-destination Survey and 1986 CTA ridership data were used to quantify the market segments.

- Potential responses to fare change were estimated using stated preference survey techniques for both CTA riders and other travelers.

- Interviews and self-completion mail back questionnaires were used for data collection.

- Relative values of fare elasticity corresponding to each market segment were derived and compared with values from other sources.

  - Whereas the absolute elasticity values derived appeared high, the relative values between markets were consistent with other sources.

  - Over two miles, distance was found not to influence sensitivity to fare change.

IX. EVALUATION OF OPTIONS

The six options were evaluated within the framework developed.

- Each option was scored according to the extent to which it achieved the aims of the ten criteria.

- A combined score was derived taking account of the level of priority assigned to each criterion.

- A sensitivity analysis was conducted to establish how robust the rank order of option values was to changes in the fare policy priorities.

- The evaluation criteria were:

  - Maximize revenue while minimizing loss of ridership

  - Maximize ridership while maintaining existing net revenue

- Ease of implementation
- Reasonableness (public acceptability)
- Revenue protection
- Cost
- Reversibility (risk)
- Equity of fares
- Simplicity
- Management information

X. CONCLUSIONS

Overall conclusions addressed three distinct issues:

i) Were the aims of the study achieved?

ii) What are the conclusions regarding CTA fares policy?

iii) How valid are Stated Preference techniques in fares policy development?

(1) Achievements

The approach adopted by the study was largely successful in meeting the study aims. In particular:

- o Using both existing data and specific new data collected using Stated Preference surveys, enabled credible values of sensitivity to fare change were derived, at the desired level of dissaggregation;
- o The market segmentation adopted was meaningful in terms of the range of fare structures finally selected for evaluation;
- o A demand model was formulated capable of providing estimates of the effects of the options on ridership and revenue to the desired level of reliability;

- o An evaluation framework was established which enabled options to be evaluated in the context of a range of CTA policy goals;

- o CTA staff were trained in the use of the evaluation framework and are using it to test complex fare structures that incorporate elements of the options evaluated in this study.

(2) CTA Results

The options which introduced peak/off peak and bus/rail fare differentials ranked considerably higher (Weighted scores of 17-18 in Table E-1) in the evaluation framework than the distance-based options (Weighted scores of 6-9 in Table E-1).

- o The high capital costs of the fare equipment necessary for distance based charging could not be justified by additional revenue raised, as this method was no more efficient at raising revenue than the present flat fare system. This is a CTA-specific survey result.

  - It is likely that the complexity of such equipment (read and write on fare media) will also increase maintenance costs.

  - The nature of CTA's rail transit system provides limited scope for staff reductions at stations, despite the higher degree of automation.

  - The scope for reducing annual operating costs to offset the capital costs is not great for CTA.

Prepayment would also achieve many of the aims identified by the study.

- o As an alternative to changing the cash fare structure, prepayment would provide a means of introducing those kinds of fare differential found to be worthwhile, at a much lower cost.

- Prepayment also offers considerable potential for exploiting opportunities in the market not easily accommodated by a cash-only fare structure. Through prepayment can be manually validated, relatively simple equipment (read fare media only) can be purchased to automate validation of the prepayment medium.

- The ranking was found to be robust to changes in priority of aims. However, a less conservative choice could be considered in the belief that wider preferences for distance charging would change.

  - Given the good absolute performance of the other options on the important ridership and revenue criteria, it was felt that there is presently no need to risk that change in preference at CTA.

(3) Study Approach

The survey method proved highly successful in meeting the needs of the study by providing disaggregated values of fare elasticity for each market.

- The method was found to be very economical in terms of data collection costs.

- It was very appropriate to this kind of application where no prior experience of rider response exists.

The survey technique has demonstrated that it provides a good method for establishing the relative sensitivity of riders to fare change in different markets.

- This information is vital in the development of fares policies which are effective in fully exploiting opportunities in an increasingly competitive market.

The overall study approach adopted was appropriate to the aims of the project and could be transferable to other urban centers.

- However, the specific results derived for CTA (in terms of ranking of options, etc.) would not necessarily be replicated.

- o Although there are many common elements in the problems of transport in developed urban centers, solutions and remedies tend to be city specific related to:
  - Physical geography
  - Population distribution
  - Existing infrastructure, and
  - Prevailing political and financial climates

Further, the ranking of options was determined by its relationship with the existing fare structure.

- o For CTA, as in many US transit systems, existing fares are very simple; all options would introduce an element of relative complexity.
- o The nature of existing fare structure is, therefore, critical to option evaluation using this approach.

VOLUME II - SURVEY REPORT

I. INTRODUCTION

The aim of the survey work was to derive soundly-estimated travel demand parameters to forecast the sensitivity of different groups of passengers to changes in fare structures.

II. SURVEY METHOD

Following a pilot survey on bus Route 94, two survey methods were adopted based on Stated Preference techniques to include both transit and non-transit travel modes.

- A self-completion questionnaire distributed at work places concerned with the journey to work.
- An interview survey conducted at centers of activity concerned with all non-work journeys.

III. METHOD OF ANALYSIS

The stated preference experimental design consisted of five factors for work journeys and three for non-work journeys; both included transit fare as one factor. Both designs adopted eight pair-wise comparisons representing a range of different factor levels.

The analysis of data used four techniques:

- Analysis of means
- Linear Strength of Preference
- Log Odds Analysis
- Inferred Mode Use Analysis

IV. PLACE OF WORK SURVEY RESULTS

The stated preference design worked reasonably well. Six parameters, i.e., levels of sensitivity, were estimated, of correct sign and of acceptable significance:

- o Transit fare, walk/wait time, travel time difference, gas price, parking cost and time.

However, the levels of sensitivity for fares derived from the survey data produced higher than expected absolute values of fares elasticity, when incorporated in the demand model.

- o It is likely that some respondents were encouraged by the questionnaire to state preferences for options which were not realistically available to them.

- o The relative values of fares elasticity between market segments were credible.

V. ACTIVITY CENTER SURVEY RESULTS

Again, the method yielded parameter values which had the correct sign and reasonable level of significance. Five parameters were estimated for:

- o Transit fare, wait time, walk time, parking time and need to transfer/direct service.

It is likely that some respondents replied as if they had a greater choice of travel mode than in reality.

- o Values of fares elasticity were higher than expected. However, it is very difficult to achieve consensus on what values of Fares Elasticity to expect for non-work travel. This is compounded when there is a complex range of travel choice, such as existed in this survey.

- o Relative values of fares elasticity were credible and generally consistent with the pattern identified for the Place of Work Survey; Non-CBD journeys were found to be more sensitive to fare changes than CBD travel in both surveys.

VI. COMPARISON OF PLACE OF WORK AND ACTIVITY CENTER RESULTS

The two survey methods were compared in terms of their effectiveness in deriving the parameters desired:

- The Place of Work self-completion survey produced significantly lower fare parameter estimates than the Activity Center Survey. This is to be expected; commuters are less sensitive to fare change than leisure travelers.

- The Place of Work Survey produced less efficient estimators than the Activity Center Survey. This is partly because the interview method adopted at Activity Centers allowed a more careful selection of appropriate trade-offs and hence greater precision in experimental design.

- Sensitivity to fare may be over-estimated in the Place of Work Survey because there is an element of self-selection of respondents.

SUMMARY OF OPTION SCORES

CRITERION	WEIGHT	OPT 1 PEAK/ OFF PEAK	OPT 2(a) RAIL ZONAL	OPT 2(b) SYSTEM ZONAL	OPT 2(c) RAIL GRADUATED	OPT 3 BUS/RAIL	OPT 4 PREPAY.	BASE
1. Max revenue, riders const	80	5	3	2	1	5	6	0
2. Max ridership, rev. const	80	5	2	3	1	5	6	0
3. Ease of implementation	20	5	3	1	2	6	4	7
4. Reasonableness	10	1	5	6	5	1	3	0
5. Revenue protection	25	4	2	1	6	4	5	4
6. Cost	80	5	3	1	2	6	4	7
7. Reversibility	20	4	3	2	1	6	5	7
8. Max rides by disadvant.	20	6	3	3	3	5	5	3
9. Simplicity	10	5	3	1	2	6	4	7
10. Management Information	5	3	5	5	6	3	1	0
UNWEIGHTED SCORES:		43	31	27	28	47	43	
WEIGHTED SCORES:		16.8	8.95	8.8	6.1	18.1	17.6	

I. INTRODUCTION

I. INTRODUCTION

Increasingly, as major transit operators are faced with declining subsidies and rising costs, they have had to look to meeting more of their costs from the fare box. There is considerable scope for introducing innovation in both the charging and collection of fares without losing ridership. In December, 1986, the Chicago Transit Authority (CTA) selected and retained LTI Consultants, Inc. to undertake a study to evaluate alternative fare structures.

The fare system adopted will be city specific, but the approach to evaluating the most appropriate will be common to all major urban centers. This study was conceived as a demonstration project and was funded with a grant form the Urban Mass Transportation Administration.

The study started in January 1987 and was substantially completed by the end of December 1987 with this report being submitted by February 1988. The study methodology encompassed a comprehensive re-assessment of fare revenue potential through an examination of fare systems and structures. The program of work was completed in three distinct phases.

(1) An examination of the existing fares system in Chicago and broad fares policy objectives were determined. An appraisal of the availability of existing data sources was undertaken.

- An Inception Report was presented to CTA in March which set out the revised work program and study methodology, encompassing the additional requirements.

(2) Data collection, and analysis to establish consumer response to fare changes. This work fell into three categories.

a) The consideration of the aims of CTA's fare policy and the development of a framework within which alternative fare options could be evaluated

b) The formulation, development and costing of alternative options

c) The estimation of the sensitivity to fare changes based on both existing data sources and data collected during stated preference surveys.

(3) The combining of the outputs from these three streams of activity to evaluate the options.

- A model was developed to forecast revenue and ridership changes for the range of fare structure options, against the implementation and operating costs involved.

* * * * *

The report is arranged in two volumes: Volume One (this volume) describes the whole study while Volume Two is intended as a detailed description of the survey work and the analysis of the survey data.

This following Section outlines the purpose of the study and assesses the validity of using stated preference techniques for this type of evaluation.

II. STUDY PURPOSE AND TERMS OF REFERENCE

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The purpose of the study was to provide an evaluation framework for a comprehensive range of fare structures. This will assist the CTA in the formulation of future fares policy for the next five to ten years. The framework developed would also provide UMTA with a methodology for assisting other major urban centers to improve their fares systems.

- o Fare structure was defined as the relative fare charged in different markets.
  - This study evaluated those in which CTA is competing. The absolute level of average fare was considered to be a separate issue, beyond the scope of this study.
- o Options were to be developed of alternative fare structures which incorporated methods of payment.
- o Alternative fare structures were to be evaluated against a base; in this case the existing fare structure of CTA's services.

The evaluation of options was to be carried out within a framework which could incorporate a range of policy goals and constraints. The evaluation framework was to be developed to allow the effect of alternative goals on option value to be demonstrated. It was also required to be capable of combining both financial and non-financial costs and benefits.

- o This would require estimates of both revenue and ridership changes associated with each option to be considered alongside cost implications.
- o Of particular concern was the likely impact of each option on disadvantaged groups such as those on low income, the elderly and non-car owning households.

The conclusions would determine which options would best meet a set of defined goals.

- o No recommendations would be made regarding the implementation of a particular fare structure or what fare policy should be adopted in future.

The study assumed that the existing bus and rail networks would remain unchanged in terms of either structure or service level.

- o Where options would depend on changes to the networks for their success and implementation, these would need to be resolved outside the scope of this study.

The options were to be developed in sufficient detail to enable both costs and ridership effects to be estimated such that the relative value of each could be judged. This would identify those options worthy of further development.

- o Costs and ridership effects would be estimated to a consistent level of accuracy

- o All options identified would be developed to a similar level of detail and none would be discarded during the course of evaluation.

- o Costs would include a consideration of the likely revenue protection implications of each option, without necessarily quantifying these in revenue terms.

For this demonstration study, the options would be considered in the context of existing plans and developments at CTA including the implications of timescales and phasing.

The study was structured to follow a logical development designed to improve the existing fares system by addressing a number of key questions. In this case the Chicago Transit Authority and their future fares policy was the subject of the demonstration project. The issues to be addressed were:

- o What are the aims of CTA and its fares policy?

- o Within what framework should fare options be evaluated?

- o What are CTA's markets and CTA's competitive position in these markets?

- o What fare options are likely to improve CTA's market position?

- o What is the cost of these options?

- o What is the ridership and revenue response to CTA fare changes?

- o What is the value of each option on the basis of the framework adopted?

- o What conclusions can be drawn from the evaluation of the options?

* * * * *

Each of the these questions is addressed in a separate Section of this report. The following Section covers the aims of fare policies and the development of future goals for the CTA.

III. AIMS OF FARES POLICIES

III. AIMS OF FARES POLICIES

The study explored a range of goals which are being pursued by CTA both in its existing fare policy and in the development of future fares policies.

- o Discussions were held with groups of CTA staff representing a broad range of departments.
- o A discussion note including a questionnaire concerning strategic trade-offs was distributed to CTA Board members.
- o Short interviews were held with a selection of board members.

In trying to formulate fares policy, it is important to recognize that some broader corporate aims may conflict; a compromise must be reached between alternative goals.

1. SHOULD REVENUE OR RIDERSHIP BE MAXIMIZED?

Increased fares are usually associated with a reduction in ridership. It is necessary to determine the optimum level of fares and ridership; in this case the number of riders CTA is prepared to lose for every additional dollar raised in fare revenue. This can only be determined by comparing alternative methods of increasing net revenue.

2. SHOULD RIDERSHIP BE MEASURED IN PASSENGER JOURNEYS OR PASSENGER MILES?

Are two short journeys as valuable as one long journey in terms of benefit to consumers? Distance-based fares are likely to reduce passenger-miles more than passenger-journeys. The way in which ridership is measured will therefore affect the valuation of distance based options. Journey maximization implies benefit to a greater number of people.

3. SHOULD PEAK OR OFF-PEAK RIDERS BE SUBSIDIZED?

Increasing fares during the peak periods is likely only to increase peak revenue but reduce peak ridership; the converse is true for the off-peak. This is effectively subsidizing off-peak riders at the expense of peak riders.

However, given that peak riders tend to be employed and therefore better able to pay higher fares, there may be a strong case for a peak/off-peak fare differential. The extent of the differential requires some judgment about the appropriate level of cross-subsidy.

4. SHOULD THE TRANSIT AUTHORITY ACT COMMERCIALLY OR PROVIDE A SOCIAL SERVICE?

The CTA, in this case, is faced with the choice of providing a service based on commercial grounds or on social need.

- A commercial approach would involve maximum price discrimination and fares would be charged according to what the market would bear.
  - In Chicago, higher fares would be charged where CTA had a strong market position such as in travel to the Loop and O'Hare, or where competitors prices were higher such as for night services.
  - Lower fares would be charged in markets where CTA's competitive position is weaker, such as for local bus services during the off-peak.
  - Where riders have no alternative to transit, they may be prepared to pay higher fares, but this should not be confused with the ability to pay.
- A social approach would imply that fares would be charged on the basis of ability to pay rather than on what riders are prepared to pay.

- CTA might prefer to improve mobility for disadvantaged groups such as the elderly or handicapped; this is the rationale behind the existing reduced fare categories.

- Some options may increase or decrease the fare differential between full and reduced fare types, but the scope for such change is limited by UMTA regulations.

5. SHOULD THE TRANSIT AUTHORITY AIM TO IMPROVE ITS OPERATING RATIO OR EXPAND ITS BUSINESS?

CTA has a choice of aiming to improve its operating ratio and reducing its subsidy or to expand its business while maintaining the existing operating ratio, which would require an increase in subsidy.

- o The operating ratio is the system generated fare revenue divided by system operating costs.

- o The operating ratio could be improved by increasing fares, but this would result in a smaller ridership with fewer passengers benefiting from the subsidy.

- o These may be alternative fare structures which raise both costs and fare revenue while maintaining the same operating ratio.

  - This would increase the subsidy.

  - More riders could thus benefit from the transit service provision and the public funds which support it.

All the above conflicts require a judgment to be made on the appropriate trade-off or compromise position. These judgments should be based on the value of a multitude of aspects concerning the business, which can only be made by those responsible for formulating the Transit Authority's aims. The indigenous demographic, geographic and socio-economic influences need to be recognized.

The evaluation framework will, as far as possible, demonstrate where each option is situated between the conflicting goals.

In addition to the major strategic choices facing Transit Authority decision makers, there are a number of sub-goals being pursued by CTA which may constrain the full achievement of the major aims. These have been identified by the Chairman of the Advanced Fare Controls Task Force and are summarized below:

- Minimize personnel requirements.
  - This implies maximum use of automation and minimum manual operations.
- Minimize cash handling.
  - Maximize the use of prepaid tickets/tokens and/or automated fare collection equipment, and minimize cash fares.
- Improve revenue security.
- Improve the convenience and simplicity of the transit system for passengers.

* * * * *

The following Section details the evaluation framework needed to evaluate the aims of the Authority and sets out the criteria for establishing such a framework.

IV. DEVELOPMENT OF AN EVALUATION FRAMEWORK

IV. DEVELOPMENT OF AN EVALUATION FRAMEWORK

A comprehensive set of criteria was established to provide a framework which would incorporate all the goals and strategic choices identified. This evaluation framework had to be designed to address not only the broad corporate aims of the Transit Authority, but also the sub goals identified by the Advanced Fare Controls Task Force.

The fare structure options were evaluated to measure the extent to which each would achieve the fare policy aims. Ten separate criteria were used in this evaluation:

- Maximize Revenue While Minimizing Ridership Loss
- Maximize Ridership While Maintaining Existing Net Revenue
- Ease of Implementation
- Reasonableness (Public Acceptability)
- Revenue Protection
- Cost
- Reversibility (Risk)
- Equity of Fares
- Simplicity
- Management Information

Each fare structure option was evaluated using each criterion. The extent to which they achieved the aim of the criteria was graded by awarding a score relative to the base option - the 1987 existing fares structure.

- o The scores represented simply the rank order in which the options achieved the aims of each criterion. This process was carried out for all ten criteria separately.

- o A weighted average score was derived for each option by combining all scores awarded under the ten criteria using weights that reflected the priority assigned to each criterion.

1. MAXIMIZE REVENUE WHILE MINIMIZING RIDERSHIP LOSSES.

Each fare structure option was assessed on its ability to raise additional revenue. This was taken as total fares revenue and ignored the revenue and capital costs associated with changing the fare structure. The assessment was based on an average fares increase of ten per cent.

- All the existing CTA fares were increased at a flat rate of 10% to provide the base option status.
- For the fare structure options, fares were increased such that the overall average across all fare categories was ten per cent; certain fares were restructured in line with the nature of the option.
    - For example, in the case of the peak/off-peak option, peak fares were increased by around twenty per cent while off-peak fares were unchanged.

This criterion assumed that the loss of ridership for the base was the maximum acceptable for the revenue gains achieved. The other options were then compared on the basis of the revenue they could generate against that maximum ridership loss.

2. MAXIMIZE RIDERSHIP WHILE MAINTAINING EXISTING NET REVENUE.

As an alternative to 1. above, options were assessed by their ability to increase ridership, both in terms of journeys and passenger-miles, while maintaining the existing level of revenue.

- The relative value to be attached to journeys or passenger-miles was left to be decided outside the framework.

3. EASE OF IMPLEMENTATION

The ease with which options could be implemented and the phasing necessary to allow a reasonable transition phase, would be reflected in the costs and timing of the expected benefits.

- The effects of timescale were evaluated by the use of discounting.

- A separate assessment to account for the complexities of each option was included.

Discounting can only account for the financial effects and it is difficult to express the uncertainties inherent in the implementation of complex projects in purely financial terms.

4. REASONABLENESS (PUBLIC ACCEPTABILITY).

An essential feature for the successful implementation and working of any fares system is the level of public acceptability. This in turn relies to a great extent on the perception and understanding which the traveling public has of the rationale under-pinning the fare structure.

- The assessment of reasonableness in this study has been derived from judgment, based on experience gained at public meetings and market research surveys, of what is likely to be considered reasonable.

    - Such sources provide an indication of the attitude of transit riders and their understanding of the costs of public transport.

5. REVENUE PROTECTION.

The effects of changes to revenue protection procedures for each option can be taken into account in estimating the change in fares revenue and operating costs.

- It became evident during discussions with CTA staff, that improving revenue protection was an aim worth pursuing in its own right. Revenue protection was therefore adopted as a separate criterion.

Options have been evaluated in qualitative terms on the basis of scope and likelihood of improvement in revenue protection.

6. COSTS.

The costs of each option have been derived by including the capital costs of fare equipment and station modification and any revenue collection costs resulting from operational and administrative changes.

- o Only costs directly attributable to the fare structure change were included. Other desirable capital expenditures should be attributed to other policy goals.

- o Capital costs have been presented as their revenue equivalent, on the basis of a discount rate of seven per cent (real) and appropriate asset life.

7. REVERSIBILITY (RISK).

For policy makers, the most difficult decisions to make are those which cannot be reversed and therefore carry most risk. Options with high expected benefits need to be valued against those which are smaller and less risky, yet have smaller expected benefits.

- o Projects which involve major commitments of capital investment in equipment which has little or no alternative use carry a high risk.

- o Projects for which no benefit is derived until the project is fully complete and take a considerable time to complete are the most hazardous of all. Often, due to rising costs, decision makers are faced with the dilemma either of approving further capital expenditure to achieve the expected benefits, or abandoning the scheme and writing off the committed expenditure.

Large projects can be made less risky if each phase is justified independently. If projects can be implemented in this way, each phase can be re-assessed to confirm that the expected benefits do materialize before it is implemented. Projects of this kind need be implemented only so far as the expected benefits exceed the cost.

In general terms, this criterion evaluates the ease with which an option can be implemented or abandoned. This will include non-financial factors such as institutional, public relations, etc.

8. EQUITY OF FARES.

Of particular concern to the CTA is how the options will affect disadvantaged ridership where this is different from the effect on average ridership.

- Because disadvantaged ridership has distinct characteristics, it was considered important to assess whether options would have a positive or negative effect on this group of riders.

- The aim under this criterion is to achieve fare equity for disadvantaged ridership within the existing level of fare revenue.

9. SIMPLICITY.

It is a stated aim of CTA fare policy to make the system simple, easily understood and convenient to use.

- As fare structures become more sophisticated in their attempts to discriminate between different markets, they tend to become more complicated for riders to understand.

  - This inevitably leads to more disputes over fares and increased difficulties of enforcement, especially with manual collection methods.

10. MANAGEMENT INFORMATION.

With any large transit undertaking involving large numbers of people, finance and considerable capital investment in equipment, effective control and administration are essential.

- o Management information systems which are both reliable and appropriate to the needs of decision makers are required. The cost of collecting and storing such information should be minimized if overheads are to be maintained at a reasonable proportion of revenue collected.

Management information may be categorized under three main headings:

- o Financial accounting and revenue control
- o Operational control
- o Marketing and planning

Each option is assessed on the extent to which management information is improved compared with the present system under each of these three categories.

* * * * *

The following Section provides a definition and analysis of the CTA's markets and their sensitivity to changes in fares.

V. DEFINITION AND ANALYSIS OF THE CTA'S MARKETS

V. DEFINITION AND ANALYSIS OF THE CTA'S MARKETS

A market based approach was adopted for option evaluation using sensitivity to fare change for market definition. Response to fare changes and increases, in particular, depend on the availability of suitable alternatives.

1. APPROACH TO MARKET SEGMENTATION

Three key factors were identified as part of this approach for market definition:

- o Journey purpose
  - i.e. work, non-work
- o Journey destination
  - i.e. Central Area; non Central Area
- o Journey distance

(1) Journey Purpose

Both work and school journeys are less sensitive to fare changes than discretionary trips which are less frequent and can be made at different times. Further, the majority of work and school journeys are made during peak hours when the highways are congested and transit service levels are highest. The alternative of traveling by car is less attractive than during the off-peak periods.

- o For work journeys therefore, additional ridership can be generated only by increasing transit's market share and attracting additional riders from competing modes (including walk).

(2) Journey Destination

The availability of alternative modes and service levels vary according to journey destination. Journeys to and from the Central Area, in particular the Loop, differ from trips to other areas due to:

- The difficulty and considerable cost of parking

- Favorable travel times provided by CTA transit services.

  - However, it is important to note that car sharing is becoming increasingly attractive as a transport mode to the Central Area.

There is considerable difference between the Loop itself and the remainder of the extended central area as defined by the Chicago Area Transport Study (CATS) in terms of parking cost. Nevertheless, transit still retains a considerably better competitive position in the extended Central Area compared to other parts of the service area.

- The Central Area was therefore divided into two concentric zones to allow for separate treatment in the analysis if necessary.

Journeys were defined as either:

- Radial - to or from the Central Area

- Local - to and from locations outside the Central Area

- Central - made entirely within the Central Area

(3) Journey Distance

Distance is important because it influences the availability of alternative modes.

- For journeys of up to 2 miles, for example, riders have the alternative to walk or cycle.

- As journey length increases, transit becomes more competitive in terms of travel time;

  - Fixed time penalties associated with access and waiting time are less significant in the context of the overall journey.

  - This is particularly true of non-stop rail services.

- Further, since operating costs are higher for longer trips, passengers may be willing to pay more.

2. OTHER FACTORS INFLUENCING FARE SENSITIVITY

Three further factors were identified as influencing fare sensitivity:

- Transit Mode
- Prepaid tickets
- Socio-economic characteristics of passengers

(1) Transit Mode

Other transit undertakings have found that sensitivity to fare changes is much higher for bus than for rail services. This is partly because rail journeys tend to be longer. In addition, rail services, and to a some degree express bus services, tend to provide a higher quality of service, in terms of:-

- Speed
- Reliability
- Comfort

An argument can be made for charging higher fares for such services and to define the ridership as a separate market.

- However, in Chicago, the CTA bus and rail networks follow a grid pattern and act as complementary services rather than in competition.
  - The distinction between bus and rail journeys in Chicago is not as meaningful as in some European cities where services are arranged in a radial configuration and include a significant element of competition.

- In most cases, bus routes intersect rail routes; for long journeys to the Central Area it is generally quicker to transfer to rail and continue the remaining journey by train.

    - This is encouraged by the transfer ticketing system which allows riders to interchange without having to pay a further full fare.

Whereas rail services form the backbone of the network over most of the CTA service area, this is reinforced in some areas particularly in the southwest by express bus services.

- For short journeys, rail and bus do compete where there are parallel routes in close proximity and where stations are close together.

- For this study, bus and rail have not been treated as serving separate markets. Rail patronage is heavily influenced by two of the key factors;

    - Journey destination
    - Journey distance

- Since rail services provide good access to Central Chicago, rail trips are dominated by Central Area journeys.

- Similarly, long journeys by CTA services are dominated by rail either entirely or in part.

It was concluded that adopting market segmentation by distance and by destination would adequately provide a meaningful level of disaggregation; a further split - by mode - was not essential for defining markets.

(2) Prepayment

Prepayment is a difficult issue since it does not fit easily into any framework which includes the geographical and socio-economic aspects discussed above.

- Whereas, the journey patterns made by passengers using prepaid tickets may differ from those made with cash fares, they do not constitute a separately identifiable market; rather they form a constituent

of all the markets so far identified (i.e., based on 1986 ridership data which indicates that about a third of all journeys on the system are made using a pass).

- Therefore, for this study, journeys made with prepaid tickets were not treated as a separate market.

(3) Socio-Economic Characteristics of Riders

The socio-economic background of passengers influences the range of travel alternatives available.

- Certain groups such as those on low income, the elderly and those from non car-owning households are dependent on public transport for their personal mobility and are therefore less sensitive to fare changes.
  - However, this lower sensitivity is unrelated to ability to pay.

While the socio-economic background of riders affects sensitivity to fare changes, it was decided not to include this as a basis for a further level of market disaggregation.

- The modelling would necessarily have been much more complex and inconsistent with the strategic nature of the evaluation framework.

3. MARKET SEGMENTS ADOPTED

On the basis of the foregoing arguments, the markets adopted for this study were:

1. Work versus Non-Work Journeys
2. Central Area versus Non-Central Area Journeys
   - Journeys which had either an origin or destination within the Central Area were defined as "radial"

- o Journeys with both origin and destination outside the Central Area were defined as local

3. Journey Distance - Grouped into Bands:

- o Journeys up to 2 miles
- o Journeys between 2 and 6 miles
- o Journeys greater than 6 miles

Note: A "cut-off" at 6 miles was adopted so as to divide the non-walk journeys into two approximately equal markets.

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The following Section discusses the generation and development of fares options available to the CTA while maximizing revenue and ridership.

VI. OPTION DEVELOPMENT

VI. OPTION DEVELOPMENT

The primary aim of generating options for evaluation, was to search for methods to maximize revenue and ridership by applying different fare structures. The approach adopted was to review different methods of charging fares to identify:

- Effects on Ridership
- Effects on Revenue

The practicalities of various charging methods were evaluated before the fare structure options were developed. The market segments identified in Section V determined the range of alternative charging methods, namely by:

- Peak/Off Peak (for the purposes of this study, it was assumed that journeys in the peak would represent an adequate approximation for work journeys)
- Central Area/Non Central Area
- Distance

In addition, it was decided to evaluate charging methods by transit mode and method of payment. Although these were not being treated as separate markets, the additional scope these would provide for alternative charging methods would enable the formulation of a comprehensive range of fare structures.

1. METHODS OF CHARGING

The five methods of charging fares were not themselves regarded as options. By estimating the ridership and revenue effects of each method separately, the subsequent effects of fare structure options (which are a blend of these different methods of charging) could be evaluated. This approach would allow the demand effects of the widest possible range of options to be estimated.

(1) Peak/Off Peak

A time based method of charging was considered because:

- The work travel market-based arguments outlined in Section V can easily be exploited by charging higher fares during the peak

- The strong operational arguments in favor of encouraging increased off peak ridership can be achieved at marginal cost

- Work journeys tend to exhibit low fares elasticity

- The CTA has already considered implementing a peak/off-peak fare differential

Since fleet size and staff requirements are determined by the peak traffic loadings, there are strong arguments in favor of charging higher fares in the peak, and encouraging greater off-peak travel where there is surplus capacity. In addition, peak hour passengers benefit from higher frequencies although they suffer from overcrowding.

- This method of charging is relatively simple to implement.

(2) Central Area - Non Central Area

Section V of this Report, on market segmentation, argued that journeys to and from the Central Area would respond differently to transit fare changes compared to other journeys and could be regarded as a separate market.

- This method of charging was combined with distance based charging to develop comprehensive fare structures for evaluation.

(3) Distance

Charging by distance was included because:

- Based on experience in other cities, fare elasticity was assumed to decrease with distance.

- Fares elasticity of long distance trips to the Central Area is low.

- The scope for generating additional revenue, particularly during the peak periods and to the Central Area is high

- The cost of providing transit services increases with distance

- Charging accordingly is seen as equitable by passengers.

It is likely that revenue increases can be achieved with little adverse effect on ridership levels. The practical implications of charging by distance need to be carefully handled; any revenue increases must be fully realized, and burdensome administrative controls minimized.

(4) Bus/Rail

In Chicago, bus and rail services are regarded not so much as separate markets, but as a straightforward means of charging both by distance and for Central Area destinations.

- Rail services tend to be faster and provide good access to the Central Area compared to bus

- Rail services tend to attract longer journeys and those with Central Area destinations

- Rail journeys generally show a lower fares elasticity than bus, and therefore offers some potential for increasing revenue

However, care must be taken in approaching this type of differential charging; in Chicago a number of journeys include travel by both modes.

- This is also counter to the CTA's responsibility for providing an integrated transit system and passengers should not be penalized for changing mode.

(5) Method of Payment

Although this is quite different in nature to the other four charging methods, a review of prepayment methods was included because:

- o The availability of a prepaid ticket amounts to an alternative fare structure

- o An element of price discrimination is introduced for the same product

There are two distinct kinds of prepaid ticket; time based and value based.

- o A value based ticket is effectively a cash fare with a fixed level of discount regardless of level of use

- o Time based tickets allow unlimited travel within a specified time and geographic area.

For prepaid tickets the fare charged per journey decreases with increased frequency of travel; the marginal cost to the rider of additional travel is zero.

- o Both types of prepaid ticket benefit riders and operators alike in terms of convenience and flexibility.

These five methods of charging provide a basis for formulating a range of fare structures by combining elements of each. Some options could involve all five methods of charging as is the case in London.

- o Each method needed to be considered in isolation to estimate how they might contribute to achieving the revenue and ridership aims of the fares policy.

  - If options which include several elements are evaluated there is a risk that the effects of each will be confused.

- o An upper limit to the revenue/ridership possibilities was determined by evaluating the effects of charging to the limits from a demand point of view, unconstrained by the practical aspects involved in fare collection.

- This would give some indication of the extent to which it was worth developing an option.

- o This effect was balanced by the assumption of change in routing to better align with a particular fare structure which allows recapture of some riders potentially lost by the new fares.

- o To a large extent, the method of collecting and enforcing fares does not significantly influence demand.

- o In considering the practical implications associated with the methods of charging it was found that very superior options appeared feasible by costing several alternatives/combinations.

The prime concern in formulating options was to include a range which explored all the possible demand effects.

2. OPTION DEVELOPMENT

The following fare structure options were developed as essential components of the fare structure analysis. These options reflect the markets CTA serves, addressing the factors affecting transit demand.

1. Peak/Off-Peak

2(a) Rail Zonal

2(b) System Zonal

2(c) Rail Graduated

3. Bus/Rail

4. Prepayment

The evaluation of these options detailed in Section IX of this report constitutes the basis for development of fare scenarios.

(1) Peak/Off-Peak

Differential fares would be charged according to the time of day, with higher fares charged during the peak. Peak periods would be 0600 to 0900 hours and 1600 to 1900 hours Monday to Friday.

- In terms of the practical details for Chicago, this option follows that proposed by the CTA in 1986. This is described in the Progress Report: "Fare Policies Analysis" produced by the Fare Policies Task Force in June 1986.

This option would require minimum change to existing fare collection equipment. The existing GFI and VisiFare equipment would be retained but specific keys would be reallocated. This was considered feasible at that time by having a separate set of buttons to register off peak fares.

The principal operational difficulty with this option is how the transition periods can be managed with minimum confusion and annoyance to the passenger. It is inevitable that on occasion, riders just miss paying their fare in the off peak period. If passengers are delayed in queues at stations during the transition period they may get very annoyed. To avoid arguments, the areas for discretion by CTA employees would need to be minimized.

- Fare equipment would need to be fully automatic such that it should not be possible to register an off-peak fare during peak periods.
  - This is technically feasible but the existing equipment may need to be modified or replaced.
- Accurate clocks should be installed in all buses and stations and controlled from a central point. This would avoid arguments about the exact time.
- On bus services, the change-over time could be enforced between stops.
- At rail stations, an audible alarm or signal could be installed; transactions in progress could be completed, but all new purchases would involve fares at the revised rates.

- In addition there should be a clear display showing whether peak fares were in force, linked to both the clock and audible alarm.

The following issues arose in 1986 and would need to be fully resolved if a Peak/Off-Peak fare structure were adopted in Chicago.

- o It was suggested that turnstiles should remain set at peak fares. Anyone using them during the off-peak would pay the peak fare. This was considered acceptable given that the turnstiles are mainly used during peak periods to avoid queueing in the station agent lane.

- o Monthly and 14 day passes would remain (at least initially) at the peak rate. However, it would be feasible to have differentially priced passes.

- o Under UMTA regulations it would be possible to eliminate reduced fares in peak periods. This would have considerable benefits in terms of operational simplicity but would restrict elderly and disabled riders to off-peak travel unless they were prepared to pay full fare.

    - It could be argued that seniors who needed to travel during peak periods to get to work could afford to pay full fare.

    - It is possible that a common off-peak fare would be acceptable. While senior citizens and handicapped riders may argue that they no longer received any special consideration, an off-peak fare set at half of peak-hour fares would still conform to UMTA regulations.

A sub-option to limit reduced off-peak fares to pass holders only was also evaluated.

- o This would enable a system of time of day pricing to be introduced without the need for modification to the existing fare equipment. Riders who wished to benefit from cheaper travel would have to buy an off-peak pass which would allow unlimited travel during the off-peak.

- As long as the journey was started during the off-peak, passengers would be permitted to complete the trip even if this meant traveling during some of the peak period. However, all trips started in the peak period, would require passengers to pay a cash fare surcharge.

- Existing monthly passes would be retained at a higher price allowing unlimited traveling at all times.

(2) Distance Based Options

These options were selected as distance-based fare structures. Three distinct options were considered:

o System Zonal

o Rail Zonal

o Rail Graduated

- The first option differs from the second in that the zonal structure is applied across the bus services as well as rail. In terms of development and practical application the principle of zonal fares is described for the system wide option.

(i) System Zonal Fares

The zonal fare structure is a distance-based option distinguished by a course fare scale. Chicago would be divided into three concentric rings:

o A central zone including the area defined by CATS as the Central Area

o An inner zone

o An outer zone

The exact positioning of the boundaries between the three zones would depend on:

- The revenue effects determined by the pattern of ridership

- The operational implications

For the purposes of this Study, the zones have been defined in general terms, (i.e., based on approximately equal market shares crossing each fare zone boundary) primarily to establish the revenue and ridership effects of imposing fares corresponding to radial journeys in the three distance bands previously identified;

  - up to 2 miles
  - between 2 and 6 miles
  - over 6 miles.

Riders would be charged according to the number of zones traversed during a journey, irrespective of transit mode taken.

- A journey started in Evanston in the outer zone to the Loop in the Central zone, would be charged for three zones.

- If a journey could be completed entirely within the same zone only one zone would be charged for.

- Where the starting and finish points were within the same zone, but the journey included travel through other zones, the fare charged would be based on the total number of zones entered.

- The fare between origin and destination could be different depending on the route chosen.

  - For instance, a journey between Howard and O'Hare Airport could be made either by train via the Loop traveling in 3 zones, or via a bus service to the O'Hare line involving only 2 zones.

  - In such cases, riders would have the choice of paying more to travel all the way by rail which is often quicker.

- o Tickets for single journeys would have a time limit of say 90 minutes and would allow unlimited travel, including free transfers, within time limit and zone.

  - All riders would need to possess a ticket valid for all zones they traveled through and for the time of travel.

This option would require a ticket common to both bus and rail. Tickets would need to be magnetically encoded to enable automatic checking at stations and by machines mounted in buses.

- o Checks for validity would be automatic at the beginning and end of rail journeys and on entry to bus vehicles.

- o In addition, tickets would be printed with the zone, fare type and expiration time. This would enable visual checking at the beginning, end or during the journey as applicable, on both trains and buses.

Zonal passes would be available to replace the existing monthly and biweekly passes.

- o Tickets for single journeys would be available either from ticket vending machines located in all stations, from station agents or bus drivers.

- o Monthly passes would be available from ticket agents and existing outlets.

Stations would be either:

- o Closed
  Riders can only enter or exit from the paid area via a gate activated by a ticket or pass

- o Open
  Where there would be no control of entry or exit

Closed stations would be staffed by a ticket agent who would be responsible for the sale of tickets and give general assistance to passengers.

- o Where riders experience difficulty in exiting from the paid area via fare gates, the ticket agent would check the validity of their ticket.

- o A penalty fare would be imposed for those who do not have a valid ticket. They would then be issued with a ticket which would allow them to exit from the system.

At open stations, tickets would only be sold from ticket vending machines.

- o Riders entering the system would be obliged to purchase a ticket before boarding the train.

- o If the vending machine fails and no back-up machine is available, riders would be instructed to take an "authority to travel" ticket from a free dispenser. This would be encoded with the station of origin.

- o The authority to travel would then be exchanged for the appropriate ticket from the agent at the station of exit, or from an on-train ticket inspector.

- o All agents and inspectors would be notified automatically of any ticket machine failure via a control center which would be linked to all fare equipment in the system.

On buses, the drivers would be in control of a ticket vending machine which would be capable of issuing single tickets valid for travel on both bus and rail services.

- o There would also be ticket validators installed on bus vehicles. The machine would notify the driver via an audible signal of all invalid tickets; additional fares would be charged as appropriate.

The success of this option would depend upon the deterrent effect of random checks on both bus and rail services.

- o Traveling ticket inspectors would aim to check 20% of all journeys. Riders found without a valid ticket would be charged a penalty fare.

- o Penalty fares would be sufficiently high so as to act as a deterrent. For instance with a one in five chance of being checked, the penalty would need to be at least five times the maximum fare.

  - This type of fare structure currently operates successfully in London.

(ii) Rail Zonal

This is effectively a sub-option of the system zonal option. Zonal fares would only be applied to rail services and bus fares would remain unchanged.

- o Journeys made entirely by rail would be charged as for the system zonal option.

- o Journeys started on rail could be completed by bus as long as the ticket was valid at the start of the bus ride.

  - Bus drivers would accept rail tickets in place of fares or transfers. However, the driver would retain the ticket and transfers to further bus services would be subject to an additional fare.

- o Journeys started by bus could be completed by rail by presenting a transfer to the station agent.

  - Transfers would be exchanged for zonal tickets on payment of a rail surcharge to cover the additional fare.

- o At open stations transfers from bus would not be valid and riders would need to pay the full rail fare.

(iii) Rail Graduated Option

This option was included to evaluate a distance based fare system on a fine scale. It would be similar to the fare structure currently operating in Washington in which the rail fare is based on the distance between the origin and destination stations.

o The more finely graduated fare scale is made possible by adopting a fully automated approach with a minimum of manual supervision.

Rail travel would be charged by distance, whereas buses would remain unchanged with a flat fare and a transfer charge.

o Fares would be based upon distance bands of 2 miles so that there would be a different fare for each station-pair.

- All stations throughout the system would be closed.

- Entry and exit from the system would only be via gates operated by a ticket obtained from a vending machine.

o All tickets would be of the stored value type up to a fixed dollar amount.

- As a rider entered the system, the entry gate would encode the station of origin and time on the ticket.

- On leaving the system the exit gate would calculate the fare for the distance traveled and deduct the amount accordingly from the ticket.

- Where there was insufficient value remaining on the ticket, the rider would be instructed to replenish the ticket in an "add fare" machine before leaving the system.

- o The existing fare structure on buses would be retained except that transfers issued on buses would not be valid on the railway system.

- \- Riders transferring from rail to bus would be able to purchase a transfer from a machine located inside the paid area which would be time limited and good for two bus rides, as with the existing transfer.

- o Stations would be attended, but by station managers rather than station agents. These managers would have overall responsibility for the functioning of the station and would only need to become directly involved in fare issues where riders were in difficulty.

The necessary basic equipment would be similar to that required for the zonal option.

- o Since tickets would only be available from vending machines, more would be required. Add-fare machines would also be required because there would be no ticket agent available to collect fares from riders with invalid tickets.

- o All stations would need to be gated. Whereas the physical appearance and configuration of the gate would be similar to the zonal option, the control logic would need to be more sophisticated to read, encode and print values on tickets.

- o Bus fare equipment on vehicles would remain unchanged. There would need to be transfer dispensing machines capable of printing the date and time of issue.

The main features of the distance based options are summarized below.

	Option 2(a) and 2(b) (Zonal)	Option 2(c) (Rail Graduated)
1.	Time/area limited tickets	Stored value tickets
2.	Stations gated only where economical;	Full closed system (all stations gated)
3.	Tickets available from agents and machines	Tickets issued from vending machines
4.	Entry/exit via gates at closed stations, from machines at open station	Entry/exit via gates only.
5.	At closed stations, agents sell tickets	System automatic, staff responsible for supervision only
6.	Agent booth required at closed stations	No agent required
7.	Fares charged by zones traversed; Route specific	Fares charged by distance,
8.	Roving ticket inspectors provide random checks to deter fare evasion	No ticket inspectors

(3) Bus/Rail Differential

This option would re-introduce the 1986-87 fare structure where rail cash fares were higher than bus fares.

- The option would increase the existing differential and also introduce differential pricing for monthly passes to be consistent with the cash fare differential.

(4) Prepayment

The aim of this option would be to maximize the use of prepaid tickets so as to minimize cash handling either on buses or by station agents. As the level of take-up increased, the existing transfers could be phased out.

Tickets would allow unlimited travel within a specified time and area. Day tickets would be self validated in that they could be valid for any day and kept until required. Validation machines would be installed in buses and at stations. Tickets would be good throughout the day of validation. Such tickets could be checked automatically or manually.

- These short term tickets would need to have a high level of availability and could be sold either by shops, currency exchanges and vending machines. Some supervision of vending machines would be desirable and these should be located in bus and railway stations, supermarkets and possibly on buses.

Longer term tickets such as weekly or monthly tickets would have higher value and should be accompanied by a photocard. Photocards would be issued to each rider on production of a passport size photograph, and allocated a unique serial number. At the time of purchase, the serial number would be written on the ticket which would then be valid only if presented alongside the photocard bearing the same serial number. Thus,the use of the ticket would be limited to one person.

- Longer-term tickets would be available from station agents and the existing outlets for monthly passes. Riders would be expected to produce their photocard at the time of purchase, but in any event the ticket would not be valid without an accompanying photocard.

Another type of prepaid ticket would be those valid only during certain periods such as during the off-peak on weekdays or at the weekends. These tickets would be sold and would function in the same way as other period tickets, except that drivers and station agents would be required to check for time as well as date and possibly geography.

- There would be no way of preventing day tickets from being used by different people. However, the ticket could only be used by one person at any time; it is considered that the extent to which they could be passed on or sold to other riders would be limited to an acceptable level.

In the case of longer period tickets, drivers and station

agents would be required to check both photocards serial numbers on the ticket. This would be difficult at busy times.

- Riders caught presenting an invalid ticket could be prosecuted on the grounds of intent to defraud given that they would have no excuse for using the ticket for any other reason. This would provide a degree of deterrence against fraud.

The ultimate intention underlying this option would be for all regular CTA users to buy a prepaid ticket; cash fares would be retained purely for the occasional user.

- Cash fares would be higher on the grounds that infrequent users (such as visitors or car-drivers) would be prepared to pay a higher fare for the convenience and flexibility of being able to use transit only on the odd occasion.

3. OVERVIEW

The six options were formulated such that each method of charging could be evaluated separately.

- All elements of the existing fare structure were retained, apart from those associated with the particular charging method being evaluated.
    - For example, in Options 2 and 3, while differential cash fares for peak/off-peak and bus/rail services would be introduced, the existing monthly and bi-weekly passes would be retained and only modified if necessary.

Although each option could be implemented as formulated, in practice it would be preferable to develop options which combined the best features of each charging method.

- This would apply particularly to Option 4.
    - This option may not only be worthwhile in its own right, but would also provide an inexpensive means of introducing charging by distance, time of day or transport mode.

- As an alternative to modifying the cash fare structure, the range of monthly passes could be extended while cash fares would remain unchanged. This could provide the benefits of both prepayment and worthwhile fare differentials.

- In place of the existing monthly pass, an element of zonal charging could be introduced by introducing monthly passes for three different zones.

  - Riders traveling regularly between Evanston and the Loop would buy a pass valid for both outer and central zones. The pass would only be checked on entry.

  - Riders expecting to travel mostly within one zone would buy a single zone pass. This would allow the rider to travel to other zones, but a cash fare would be required for the return journey.

This approach would introduce distance based fares for all regular journeys. Its convenience for passengers would be increased if the number of coin operated turnstiles accepting the Quikpass were extended.

An additional form of the existing method of prepayment is that provided by tokens.

- While this method does have advantages to both the operator and rider, tokens provide a fixed level of discount to cash fares and do not constitute a different fare structure.

  - Within the scope of this study, tokens were not considered as a basis for a separate option.

4. AUTOMATION

A further issue that was not directly addressed in the development of options is the use of automation in fare collection. The development of options described above concentrated on alternative fare structures and treated automation as a secondary consideration.

- o Developments in fare equipment technology could facilitate the implementation of alternative fare structures and are essential for at least one option to be implemented.

- o Whereas increased automation could achieve some aims of CTA's fares policy (such as revenue protection) it was not considered to be a principal concern of the study and thus was not considered as dimension.

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The following Section of the Report considers the costing of the various options outlined.

VII. OPTION COSTING

VII. OPTION COSTING

The previous section outlined the six options which were evaluated by the study. This section describes how these options were costed.

Of the options developed, those based on charging fares by distance are expected to be the most expensive to implement. Their nature will require considerable capital investment for new machinery and station modifications. The other options will incur some implementation and/or increased revenue collection costs.

1. OPTION 1 - PEAK/OFF-PEAK

It was assumed that there would be no change in the revenue (operating) costs associated with this option; for instance, neither staff levels nor operating costs should be affected by slightly longer bus boarding times.

- o In terms of capital costs it was assumed that the existing GFI fare boxes could be retained on buses requiring minimum modification costing $100 per vehicle.

- o On rail, it would be necessary to replace the existing visi-fare machines at a cost of $2,000 per unit.

2. OPTION 2 - DISTANCE-BASED OPTIONS

Three options were considered:

a) - Rail Zonal

b) - System Zonal

c) - Rail Graduated

(1) Costing Approach

For the costing exercise, it was assumed that the arrangement of fare gates at stations would be similar for both zonal and graduated options.

- o Although the stored value ticket used in Option 2C is more sophisticated in terms of system logic and the need to print revised values on tickets, the fare gate itself essentially performs the same physical task.

Riders would need to enter and exit the paid area via automatic gates, and have a ticket prior to entry.

- o In Option 2(c), riders would only be able to obtain tickets from vending machines.

- o In the zonal options [2(a) and 2(b)] tickets would be available from both station agents and vending machines.

The zonal options therefore would require a booth located where the station agent can serve riders in both the paid and unpaid areas.

- o Option 2(c), which is fully automated, requires accommodation for station staff but it is not essential that this needs to be located within the barrier.

  - It would be useful, but not essential for the booth to be within sight of the fare equipment and this added flexibility provides the opportunity to reduce the high costs associated with relocating existing agents' booths.

The stored value ticket used in Option 2(c) requires that all stations are gated to allow the cost of the journey to be deducted from the value of the ticket.

- o The ticket used in the zonal options would have a fixed value corresponding to a specific time and area, and once issued would only need to be checked for validity.

In the zonal options there is considerable potential for reducing the cost of station modifications.

- o At those stations where traffic and the revenue at risk is small, an open station approach can be adopted. In most cases, open stations would not be staffed (at least not full-time) and tickets would be available from vending machines.

This approach does not rule out the possibility of maintaining some station supervision and for costing purposes it has been assumed that existing overall staffing levels will be maintained.

- o However, it has been assumed that that there would be sufficient savings in station staff to provide a pool of ticket inspectors to work both on trains and at stations, carrying out random ticket checks.

In costing the distance based options, the existing layout and existing facilities need to be established to determine the new facilities and station modification required.

- o For the graduated option [2(c)] it was assumed all stations would be gated. Agents' booths would be retained (but not necessarily staffed full-time) where these were suitable.

  - Life-expired agents booths would be removed and it has been assumed that the accommodation for the station supervisor would be provided elsewhere.

- o For the zonal options, agents booths would need to be located with access to both paid and unpaid areas at all closed stations.

  - Where the existing booths are modern, it has been assumed that these could be modified to provide a window(s) for the agent to serve passengers in both paid and unpaid areas.

  - Life-expired booths and those in a position incompatible with the required configuration of gates, would require provision of a new booth to modern standards.

- At open stations, the existing booths would be retained and staffed as necessary (no costs were included for any modification or replacement of booths at open stations).

Ticket vending machines could be provided at all stations; those which would be open under the zonal options, would have a minimum of two machines.

- o Busy stations would have a station agent and a fewer ticket machines.

The graduated option would also require "add-fare" machines inside the paid area.

- o It has been assumed that a minimum of two "add-fare" machines would be needed at every station.

Rather than estimate costs for the distance-based options separately, costs were first estimated for the graduation option [2(c). These costs were then modified to derive costs for the zonal options [2(a) and 2(b)].

(2) Station Modification

The CTA rail system has 143 stations some of which have two entrances; the total number of entrances is 173. On the basis of advice provided by CTA, approximately 30 stations were selected to represent the full range of different types in terms of age, configuration and size. Drawings showing their layout were also provided.

- o On the basis of visits made to all 30, sketch plan layouts of the revised configuration of gates and agents booths were developed which would be required under Option 2(c).
  - Although an agent booth is not required for this option, they were included at this stage to provide the necessary data to cost the other options.
  - The sketch plans assumed a minimum of three gates per station - one inbound, one outbound and one reversible.

- During the course of the visits, it became apparent that the modifications necessary to install gates could be reduced to a relatively small number of operations which would be common to some degree at all stations:

    - Removal of existing turnstiles
    - Removal of rotogates
    - Installation of new gates
    - Modification of windows to existing agents booth
    - Provision of new agents booth
    - Installation of ticket vending machines
    - Modification of existing barrier line

Cost estimates were provided by CTA for these modifications based on twelve stations selected from the sample of thirty.

- Stations were grouped into categories by attributes:

    - At Grade Old (e.g., Harlem-Lake)
    - Elevated,
    - New Surface (e.g., Cumberland)
    - Sub Surface
    - Loop Elevated

The cost estimates derived were extrapolated to estimate modification costs for the entire system.

(3) Fare Equipment

It was assumed that for Option 2(c), all stations would be equipped with a minimum of three fare gates. Where more gates would be required, the number was calculated using the following procedure:

(a) The peak 15 minute passenger flow rate was multiplied by 1.3 to allow for the flow in the reverse direction.

- At stations where it was considered that there would be a balanced flow in both directions during peak hours, the peak 15 minute flow rate was doubled.

(b) The resulting 2-way flow rate was rounded up to the nearest hundred.

(c) A further one hundred was added at stations where traffic conditions or site were considered particularly difficult.

(d) The resulting flow rate was then multiplied by 0.4 to give an estimate of peak 5 minute flowrate.

(e) The flowrate was divided by 125 to estimate the total number of gates required.

(f) This figure was rounded up to the nearest whole gate.

The above procedure assumes the capacity of a gate is approximately 21 passengers per minute, and allows adequate spare capacity to provide for gate failure.

A minimum of two ticket vending machines were assumed to be required at all stations. However, where space is extremely restricted, it may be uneconomic to rigidly enforce this rule; it should be possible to find alternative arrangements to ensure that one machine would be adequate.

o In the case of the zonal options, a simple "authority to travel" dispensing machine could be installed and would become operational on failure of the main ticket vending machine.

  - This "ticket" would be accepted by ticket inspectors or station agents who would be informed that the vending machine at that station had failed.

- o At stations where two machines would be inadequate, the number of ticket issuing machines required was calculated by making the following assumptions:

(i) For graduated option:

- Process capacity of vending machines at 6 per minute applied to the peak 15 minute flowrate of inbound passengers.

(ii) For zonal options:

(a) At closed stations

- 40% of passengers would purchase their tickets from the station agent, while 60% would obtain tickets from a passenger operated machine.

- Both streams would obtain tickets at a rate of 6 per minute.

(b) At open stations

- The vending machine would be capable of issuing tickets to 100% of passengers.

- The rate of ticket issue was applied to the peak inbound flowrate of passengers.

(4) Bus System

Option 2(c) assumed that the fare structure on buses would remain as at present; no costs associated with new fare equipment would be incurred.

- o For Option 2(b), bus fares would be within a common zonal system. All vehicles would be equipped with a driver-operated ticket machine which would issue magnetically coded tickets compatible with those for the rail system.

  - In addition, the vehicles would be equipped with two ticket validators. This assumes that

passengers board in two streams and that those without tickets board in the stream adjacent to the driver.

(5) Cost Model

The overall costs of the distance based options are crucially dependent on the assumptions outlined above. Given the tentative nature of the schemes, it is not possible to be definitive about some of the details and any costs used will be subject to wide variation. (NB. Cost estimates were for planning decisions rather than providing the level of reliability based on engineering estimates required for bid purposes.)

o Nevertheless, it is important to be clear about the structure of the costs and to be able to identify the principal components which drive the overall costs.

A cost model was formulated to explore the sensitivity of the total cost to changes in the various assumptions made. The key assumptions which the model allows to be varied are:

- Cost of gate
- Cost of ticket vending machine
- Capacity of gate
- Capacity of ticket vending machine
- Ratio of reverse flowrate to peak flowrate
- Cost of installation of fare equipment
- Cost of new agents booth including installation
- Cost of engineering design and planning
- Cost of change to station graphics
- Cost of demolition

(6) **Treatment of Auxiliary Exits**

At about 41 stations there is an arrangement where riders can exit but not enter the paid area. These exits are usually controlled by rotogates.

- In some instances, the gates are remote from the station platform and are out of sight of the agent booth. Such exits present a problem; it could be costly to install automatic gates which would not be in a position to be supervised by the station agent. Conversely, it would be inconvenient for some riders to be obligated to use a particular exit.

A number of solutions are possible, depending on local conditions and station configuration:

- Where the auxiliary exit leads to a street not remote from other station exits, and the additional walking distances incurred are not unreasonable, the auxiliary exit could be closed.

- Where it is considered desirable to retain the auxiliary exit, it may be possible to retain the existing rotogate in its remote location and install an automatic gate (exit only) in a different location, either closer to the station agent or in view of the station platform.

  - This would reduce the risk of vandalism and retain the long walk-ways within a protected area.

- In some situations it may be unavoidable to locate automatic gates remote from both platform and station agent and in these cases it would be necessary to install closed circuit TV cameras or some other form of remote supervision.

The most appropriate solution at each station will depend on the local conditions and therefore no overall fixed rules can be applied.

- An appraisal should be carried out to evaluate passenger inconvenience incurred by closing auxiliary exits against the cost of equipping the exit with gates.

- The inconvenience can be quantified by estimating the resulting loss in ridership using the following relationship:

$$Q = \frac{D \times VOT \times N \times E}{V \times f}$$

Where: Q = Loss in passenger-miles
D = Extra walking distance
V = Walking speed
VOT = Value of walking time
N = No. of passengers using exit
E = Fares elasticity
f = Average fare per mile.

(This relationship has been derived and verified as part of the appraisal of station closures in London.)

The approach adopted in taking the auxiliary entrances into account in station modification costs assumed that all existing exits would be gated.

- This would therefore provide an upper limit to the costs.

A second estimate was then made assuming all exits were closed, to provide some indication of the size of the costs associated with retaining auxiliary exits.

(7) Treatment of Difficult Cases

In certain cases, the configuration of the station is such that the costs associated with the necessary modifications for installing automatic fare gates would be uneconomic.

- For instance, at Cicero on the Lake Street line, the fare controls are currently situated on the elevated platform and there is insufficient space to install automatic fare gates. Since there is no space available at street level, it would be necessary to construct additional space above ground which would require considerable capital expenditure.

- Given that the traffic at this station is very low (135 in the peak 15 minutes), large-scale capital investment would not be justified, unless this was part of a larger scheme to modernize or refurbish the station.

o In the case of the zonal options, a station such as Cicero would be operated either as open or have some form of manual ticket checks.

o In the case of the graduated option, it would be necessary either to close the station for passenger operation or to incur the high modification costs.

Such stations have been treated as exceptions in the costing exercise and highlighted as special cases for separate consideration.

(8) Revenue (Operating) Costs

Revenue (operating) cost changes would arise primarily as a result of the changes in staffing levels. There would also be some material costs for additional spares for fare equipment maintenance.

In terms of staff levels:

o Option 2(a) (Rail Zonal) would require increased staff to provide a form of uniformed ticket inspectors, particularly in parts of the system when there are open stations.

  - This would be off-set by a reduction in the number of staff at open stations and the availability of ticket vending machines located at all stations.

  - Therefore, it has been assumed that the savings in station agents would be sufficient to provide a team of ticket inspectors adequate to maintain fare evasion within reasonable limits. There would be no net change in staffing levels.

- Option 2(b) (System Zonal) would incur extra staff costs associated with the bus system. Ticket inspectors would be needed to enforce the distance based fares on buses but there would be no staff reductions to off-set this.

  - It has been assumed that a team of 50 ticket inspectors would be required at a cost, including overhead of $50,000 p.a.

- Option 2(c) (Rail Graduated) would not necessarily need a team of ticket inspectors because all stations would be gated.

  - If it is assumed that it would be no more difficult to gain entry to the paid area without paying than at present, then, in the absence of ticket inspectors, the level of fraud should remain virtually unchanged.

  - However, the need to have a ticket would provide the opportunity to check riders for fares evasion; the cost of doing so would need to be justified by the extra revenue collected.

All three distance-based options will incur costs for fare equipment maintenance. Although the existing system involves considerable maintenance costs, these options would introduce more sophisticated equipment which would inevitably be more costly to maintain.

- Many of the existing station turnstiles are relatively old, but apart from the coin-operated turnstiles which accept coins/tokens and issue transfers, most are extremely basic requiring little maintenance.

- Automatic gates need to accept, process and return a ticket as well as control the opening/closing mechanism of the gate itself.

  - All distance-based options include ticket vending machines which also include a considerable degree of complexity.

- To allow for the additional maintenance required a nominal 5 percent of the equipment capital cost has been assumed for the annual maintenance cost of labor and materials

(9) Computing Facilities

It has been assumed that the automatic fare gates and ticket vending machines at stations would be linked to a central control function. This would enable the status of the equipment to be monitored on a continuous basis and would provide a warning signal of equipment failure.

- In addition, the control equipment would enable management information covering revenue and ridership to be collected and stored electronically.

ridership to be collected and stored electronically.

To provide these facilities, the costs have accounted for the central computer and one small computer at all stations. Unit costs are shown in Appendix D.

3. OPTION 3 - BUS/RAIL DIFFERENTIAL

Since this method of charging was introduced in the fares revision of February 1986, the only costs associated with this option would be those for the introduction of a bus-only monthly and bi-weekly pass if this proved necessary. These costs would be expected to be minimal and have not been included in the evaluation of this option.

4. OPTION 4 - MAXIMUM PREPAYMENT

The prepayment option would involve an expansion of the existing facilities for producing, distributing and administering bi-weekly and monthly passes.

- The costs associated with this expansion have been based upon a study carried out by CTA in October 1985 which considered the introduction of bi-weekly or weekly passes entitled "Analysis of Weekly and Bi-Weekly Pass Alternative Impacts".

This study identified the basic components of cost as:

- Administration
- Printing
- Distribution and Commission
- Marketing

Costs were based on the volume of passes expected to be sold. This study has assumed that pass take-up would increase to a maximum of 70% - approximately double the existing level of usage.

- o Costs were derived by pro-rating the CTA study costs accordingly.

A crucial aspect of Option 4 would be to increase the availability of prepaid tickets compared with the existing outlets. Not only would these need to be increased by expanding the range of commercial undertakings willing to sell passes over the counter, but automatic vending machines would also be included as an integral component of the distribution network.

- o These machines would be located where they could at least be partly supervised. (For example, inside supermarkets and banks). Prepaid tickets would be printed at the time of issue to prevent theft of ticket stock.

  - There has been considerable development in the facilities provided by such machines with a trend towards automatic credit transfer, away from cash handling.

  - This development would further enhance the security of fare revenue while enabling a widespread system of distribution to be provided.

The costs for Option 4 assumes 500 ticket vending machines located throughout the service area at a unit cost of $2,000. These machines would require regular servicing, but this cost would be included within the revenue costs associated with pass distribution.

- o Machines would be installed only if they could be justified on savings made in the existing method of distribution.

The implementation and revenue costs of each option are summarized in Table 7.1 following this page. Further details of the option costing exercise is included in Appendix D.

*   *   *   *   *

The following Section describes the data requirements for market segmentation and options development.

FIGURE 7.1

COST OF OPTIONS

Estimated Range

OPTION	CAPITAL COST $ (million)	REVENUE EQUIVALENT OF CAPITAL $ m/pa.	OPERATING REVENUE COST $ m/pa.	TOTAL ANNUAL COST $ m.p.a.	COST PER FARE $0.00
1. PEAK/OFF PEAK	0.41 - 0.81	0.03 - 0.07	-	0.03 - 0.07	0.01 - 0.02
2(a) RAIL ZONAL	40-68 - 55.44	3.37 - 4.60	2.03 - 2.77	5.41 - 7.37	1.73 - 2.35
2(b) SYSTEM ZONAL	49.68 - 68.94	4.12 - 5.72	4.98 - 5.95	9.10 - 11.66	2.91 - 3.73
2(c) RAIL GRADUATED	67.28 - 92.08	5.58 - 7.64	3.36 - 4.60	8.94 - 12.24	2.86 - 3.91
3. BUS/RAIL	-	-	0.38	0.38	0.12
4. PREPAYMENT	0.75 - 1.25	0.18 - 0.29	2.84 - 3.71	3.02 - 4.00	0.96 - 1.28

VIII. DATA SOURCES

VIII. DATA SOURCES

Previous Sections of this Report described the approach to market segmentation and options development to achieve the aims of fares policy. This section describes the data requirements arising from these earlier stages and the data sources used.

Two kinds of data were required to estimate the demand effects of the fare options in terms of ridership and fare revenue changes, these were:

- o Market Definition: Pattern of Journeys
- o Market Response to Fare Changes: Fares Elasticity

1. MARKET DEFINITION: PATTERN OF JOURNEYS.

All the data used for quantifying the CTA's markets were extracted from existing data sources, except that for prepaid tickets. This was supplemented by data collected from a Travel Diary Survey conducted by the CTA during August 1987. The analysis of the existing data sources is described in detail in Appendix A(i).

The aim of the analysis was to quantify:

- o The size of each market and,
- o the competitive position, in terms of market share, of the CTA services within each market.

This quantification would form the basis for the modeling work required to estimate the effect of each fare option on ridership demand.

All possible sources of data were explored to consider which would be most appropriate to use. Data on travel pattern were extracted in such a way that the level of consistency between sources would be established.

The primary sources of data used were:

1979 Origin Destination Survey (CTA)
1986 Trip Component Survey (CTA)
1980 Census Journey to Work
GFI and Visifare Data (CTA)
Monthly Operating Reports (CTA)
1970 Transportation Study (CATS)
1979 Household Survey for Trip Generation (CATS)
1985 Population Estimates of Chicago's Community Areas (City of Chicago)

The basic component of the travel patterns described was a one way journey defined as:

- the travel between an <u>origin</u> (such as home) and a <u>destination</u> (such as work).
  - In the CTA's terminology, a journey would be equivalent to a "linked trip".

Cash journeys were those where the rider paid a cash fare at the time of travel. Pass journeys were those made using a monthly or bi-weekly pass.

- The total number of cash journeys carried by CTA was derived from the number of fares collected; it was assumed that only one journey was made for each fare. This ignored any reverse riding or illegal journeys.

- The number of pass journeys carried by the system was derived by dividing the number of trips made with a pass (recorded by GFI and Visifare equipment), by the number of trips per journey estimated by the 1986 Trip Component Survey.

- The total number of journeys for 1986 was estimated to be approximately 1.2 million per day or 360 million per year.

Of the total daily journeys, it was estimated that 54 - 57% were made entirely by bus and 43 - 46% were rail journeys - (those involving any rail trips).

- These percentages were based on CTA ridership data and also the 1979 Origin Destination Survey. The ranges in percentage indicate the difference between the two sources.

- There was good consistency between CTA 1987 ridership data and the 1979 Origin-Destination Survey.

The total daily traffic was divided into peak (53%) and off-peak (47%) using CTA ridership counts.

- This breakdown will be cross-checked against the results of a special survey based on the GFI and Visifare data collection methods organized by CTA in December 1987.

The geographical distribution of journeys was based on a combination of the 1979 Origin-Destination Survey, the 1980 Census data and the 1970 Chicago Area Transportation Study. The CATS data were used only as a source for non-work auto journeys.

- Although these data sources were relatively out of date, it was considered that the pattern of these journeys would be reliable enough for the purposes of this study.

  - The journey pattern was partly adjusted by factoring the matrices using CTA 1987 ridership data and the 1986 Cordon Count of traffic entering and leaving the Loop.

- Around 49% of peak bus journeys are to/from the Central Area, falling to 37% in the off-peak.

- Around 63% of peak rail journeys travel to/from the Central Area, falling to 50% in the off-peak. The radial market is more significant for rail.

CTA's Bus and Rail services are more competitive in the radial markets attracting around 60% of all journeys in the peak and 56% in the off-peak.

- This market share increases to 77% in the peak if only those journeys to the Loop are included rather than the larger Central Area.

- o As expected, CTA's competitive position is weakest in the local off-peak markets, attracting 20%.

- o If market shares are examined on the basis of distance alone, CTA does least well for journeys of less than 4 miles, even without taking walking and cycling journeys into account.

2. MARKET RESPONSE TO FARE CHANGES: FARES ELASTICITY.

The study based estimates of the level of sensitivity to fare change on three sources:

(a) Time series analysis of CTA ridership data

(b) Review of literature

(c) Survey data

(1) Time Series Analysis of CTA Ridership Data

An analysis of the effects of the 1981 and 1986 fare increases was carried out using CTA's ridership data extracted from the Monthly Operating Status Reports. This analysis is described in more detail in Appendix A(ii) and the results are summarized in Figure 8.1 below:

FIGURE 8.1

ESTIMATED VALUES OF FARES ELASTICITY FROM CTA RIDERSHIP DATA

DATE OF INCREASE	FARES INCREASE	FARES ELASTICITY BUS	RAIL	SYSTEM
Jan 1981	30%	0.20	0.03	0.17
July 1981	12%	0.66	0.16	0.59
Feb 1986	18%	0.33	0.28	0.27
AVERAGE FOR ALL INCREASES		0.40	0.14	0.34

These results show the wide variation in estimated fare elasticity associated with the various fare increases. This is particularly marked in the case of rail. One possible explanation for the wide of variation is the changing discount for passes.

o Following the January 1981 increase, the small ridership loss may have been due to the large increase in pass discount causing cash fare travelers to transfer to pass. Once riders have purchased a pass, they tend to make extra discretionary trips . This generation effect reduces the impact of a fare increase, and riders switch ticket types rather than modes.

o There was a much greater loss of journeys caused by the 1986 fare increase particularly on rail, which had a relatively higher fare increase. In this case, there was little increase in pass discount offering little scope of an alternative to cash fares. While pass sales and usage did increase significantly, this is also attributed to the accompanying major change in transfer regulations.

As a means of validating these estimates of fare elasticity, data extracted from the CBD Cordon counts were analyzed and the results are shown in Figure 8.2 below:

FIGURE 8.2

REDUCTION IN CBD TRAFFIC FROM CORDON COUNTS

	ALL DAY		FARES ELASTICITY	
DATE	**BUS**	**RAIL**	**BUS**	**RAIL**
1981	**-3%** **-15%***	**-3%** **-3%***	**-2%**	**-2%**
1986	**-7%** **-5%***	**-7%** **-7%***	**-7%**	**-4%**

*** Note : These figures are from 1987 CTA Ridership data**

There was a good degree of consistency between the two data sources except for bus journeys following the 1981 fare increase; the CTA ridership data suggested a 15% loss of unlinked trips compared to the Cordon count of 3%.

- This suggests that radial bus journeys were much less sensitive to the fare increase. There may also have been a reduction in the average number of rides per journey and if radial journeys are assumed to have a higher proportion of single ride journeys, this would further explain the discrepancy.

- These results also suggest that off-peak journeys are on average about 50% to 75% more sensitive to fare increases than peak journeys (with the exception of bus in 1986 which appear to exhibit no difference between peak and off-peak).

The analysis of ridership data also identified a consistent relationship between the level of pass usage and the price discount in pass trips. This was used as a basis for the model used to evaluate the demand effects of Option 4.

(2) Review of Literature

A review of recent literature was undertaken to establish what values of fare elasticity would be expected to exist in Chicago. This is described in Appendix A3, and covered a range of reports on studies carried out in various U.S. and U.K. cities. The general conclusions from this review were:

- An average transit fare elasticity value of -0.3 +/- 0.16.

- Bus fare elasticity is up to twice that of rail.

- Off-peak fare elasticity is up to twice peak fare elasticity.

- Fare elasticity decreases with distance.

- Non-CBD journeys exhibit a higher elasticity than CBD journeys.

- o Elderly riders are more sensitive to fare changes than the average rider.

Methods for estimating fare elasticity may be conveniently divided into three groups:

(a) Time Series Analysis
- The variation in fares and demand over time.

(b) Cross-sectional Analysis
- The variation in fare and demand over a geographical area.

(c) Stated Preference Analysis
- Response to variation in fare in hypothetical situations as stated by individuals.

Methods (a) & (b) are based on revealed preference data: how people actually respond to fare changes.

- o Time Series Analysis is considered to estimate short-term elasticities compared to Cross-sectional Analysis, which accounts for structural changes in travel patterns such as land-use changes.
  - Elasticities estimated using the Time Series Analysis method are generally lower than those using the Cross-sectional Analysis method.

(3) Survey Data

It was recognized from the outset that the existing data sources alone would not be an adequate basis for estimating the sensitivity of CTA ridership to fare changes. Whereas some analysis of CTA ridership had been undertaken to derive values of fare elasticity following previous fare increases, these data would be inadequate to enable the research to be developed much further.

As the study was concerned with the demand effects of different fare structures, the variation in fare elasticity between market segments needed to be estimated. Additional data was collected using a consumer preference survey.

- The most appropriate survey method was based on stated preference trade off techniques. This would allow sufficient level of disaggregation, required to estimate the effects of the options, without involving a large and costly data collection exercise.

  - The full details of the survey including the data analysis is described in a separate report.

An initial pilot survey was carried out on CTA Bus Route 94 on April 13, 1987 to establish the transport alternatives available to CTA riders. The main survey then adopted two different survey methodologies:

- For journeys to work
  - A mail-back self-completion card survey was distributed at places of work to both CTA and non CTA users.

- For non-work journeys
  - An interview survey was carried out at activity centers (such as shopping malls) attracting journeys for all purposes except work, by all modes of travel including walk.

Both survey methods were developed by extensive piloting, in which problems with data collection and questionnaire comprehension were eliminated as far as possible.

- The data from the pilot surveys were analyzed to ensure that the data collected would be adequate to meet the requirements of the study.

- During the main place of work survey, 6,000 questionnaires were distributed of which 1,100 were returned. 25 centers of employment were surveyed throughout the CTA service area.

- The main activity center survey conducted 895 interviews at 25 centers including shopping, leisure and recreation, and health centers, within and beyond the CTA service area.

A variety of methods of analysis were employed using primarily the SPSS statistical software package and ALOGIT.

- The analysis derived parameter estimates corresponding to the effect of fare variation on modal choice for each of the market segments adopted earlier in the study.

    - These fare parameters were then used in conjunction with the journey data described in the first part of this section, to formulate a demand model designed to estimate the demand effects of the fare structure options.

    - The demand model is described in Appendix C.

To compare the values of fare parameters derived from the survey work with the values of fare elasticity , it is necessary to represent the parameters as elasticities using the base mode shares.

- The average value for fare elasticity derived directly from the survey results was -0.62 for all day; (-0.38 for the peak and -0.82 for the off-peak).

- Given that these values are considerably higher than would normally be expected, various explanations were explored.

    - On examining the journey data, there appeared to be a marked discrepancy between the proportion of riders who came from car available households (77%) and the proportion who stated that a car was available for the journey (36%).

    - This implies that the stated preference questionnaire encouraged individuals to respond assuming a car would be available for their journey, whereas in practice, this may not always have been the case.

In translating the mode split model from the individual to the aggregate level, car availability for the journey was used to reinterpret the base probability of traveling by car.

- The values of fares elasticity implied by changes in transit share at the aggregate level were therefore much lower.

- These values are set out in Figure 8.3 below:

FIGURE 8.3

VALUES OF FARES ELASTICITY DERIVED FROM SURVEY DATA

MARKET SEGMENT	PEAK	OFF-PEAK
Central	0.26	0.39
Radial	0.11-0.13	0.36-0.39
Local	0.19-0.24	0.41-0.44
> 2 Miles	0.29	0.49
Overall:	0.19	0.44
Average all day:	0.33	

Note: The ranges quoted above for Radial and Local market segments correspond to the further disaggregation into inner and outer zones.

The above table shows the relative elasticity values between the various market segments.

- Off-peak elasticity is more than twice the peak elasticity

- The radial markets have a lower fare elasticity than the local market but the difference is much more pronounced in the peak.

- Journeys of less than 2 miles exhibit a higher level of sensitivity to fare change than journeys greater than 2 miles.

In estimating the demand effects of the different options, the study was concerned with identifying how alternative fare structures would compare with the existing structure in affecting demand.

- The difference between fare structures is a function of the variation in elasticity between market segments, rather than the absolute average elasticity value.

- Since the average value adopted is applied to all options including the base, a change in absolute value does not affect the relative performance of each fare structure.

  - Further detailed analysis of the fare structures is provided in Appendix D.

* * * * *

The following Section describes the evaluation of the fare structure options within the established framework.

IX. EVALUATION OF OPTIONS

IX. EVALUATION OF OPTIONS

This section covers the evaluation of the fare structure options within the framework described in Section IV.

- An assessment was made of the extent to which each option achieves the aims under each criterion.
  - During this process, a score was awarded to reflect the achievement relative to the base option (the current fares structure).
- All options were awarded a score between 1 and 6 where a score of 6 indicated the better option.
- The scores represented the comparative rank order of each option rather than implying any relative value between options.
- Each of the ten criteria was awarded a weighting between 0 and 100 by key decision-makers - the CTA Board - to reflect the relative importance of each.
  - These were varied to illustrate how the level of priority assigned to each criterion affected the value of each option.
- The option scores under each criterion were then combined to a weighted total score which indicated the overall value of each option.
- To demonstrate which options would be worth implementing, the option scores were re-calculated relative to the base score for the existing fare structure.
- Positive scores indicated those options with a higher value than the base and hence worth implementation.

- o Negative scores indicated those options with a lower value than the base and hence not worth implementation.

The ten criteria adopted for the evaluation framework were:

- o Maximize revenue while minimizing loss of ridership
- o Maximize ridership while maintaining existing net revenue
- o Ease of Implementation
- o Reasonableness (public acceptability)
- o Revenue Protection
- o Cost
- o Reversibility (risk)
- o Equity of Fares
- o Simplicity
- o Management Information

1. MAXIMIZE REVENUE WHILE MINIMIZING LOSS OF RIDERSHIP

To evaluate the potential of each option to increase fare revenue while minimizing ridership losses, the average overall fare for all options (including the base) was increased by 10%. The results are shown in Figure 9.1 following this page.

The annual revenue increases were expressed as the ratio of dollars gained for each journey lost and each passenger-mile lost.

- o It is very important to recognize the distinction between these two measures. In particular, the results for option 2(b) show that the reduction in passenger miles is 5.3% against a 0.5% reduction in passenger journeys. This indicates a major reduction in average journey length.

FIGURE 9.1

EFFECT OF TEN PERCENT INCREASE ON REVENUE AND RIDERSHIP

OPTION	AVERAGE FARE INCREASE	CHANGE IN JOURNEYS m.p.a. (%)	CHANGE IN PSGR. MILES m.p.a. (%)	CHANGE IN REVENUE $ m.p.a. (%)	REVENUE PER JOURNEY LOST $	REVENUE PER PSGR. MILE LOST $
BASE OPTION	10%	-10.0 2.8%	-56.0 2.7%	22.0 6.9%	2.20	0.39
1. PEAK/OFF PEAK	10.2%	-6.1 1.7%	-29.9 1.5%	26.1 8.2%	4.28	0.87
2(a) RAIL ZONAL	10.1%	-7.9 2.2%	-57.2 3.0%	21.1 6.6%	2.67	0.37
2(b) SYSTEM ZONAL	10.2%	-1.9 5.0%	-102.4 5.3%	13.6 4.3%	7.16	0.13
2(c) RAIL GRADUATED	10.7%	-11.0 3.0%	-67.0 3.2%	13.6 7.5%	2.18	0.36
3. BUS/RAIL	10.2%	-5.9 1.6%	-34.9 1.8%	25.0 7.9%	4.23	0.72
4. PREPAYMENT	10%	-3.5 1.0%	N/A	27.9 8.7%	7.97	N/A

The relative importance attached by the Transit Authority to passenger miles or passenger journeys as a performance indicator will determine the relative success of each fare structure to meet the aims of this criterion.

- o A further measure for assessing the performance of each option was to assume that the maximum loss in ridership which could be tolerated was that for the base - a loss of around 3% of journeys.

- o Under Option 2(c), the loss in ridership arising from the 10% overall fares increase is not significantly different from the base; hence this option has not been included in the performance comparison.

- o Figure 9.2 following this page compares the results of each option.

In terms of achieving the aim under this criterion:

- o Option 4 (Prepayment) appears to be the most effective in raising revenue at $8 per journey lost.

  - However, given the complexities of the mechanism by which riders trade between cash and pass and the difficulty of attempting to model this process, these results should be viewed with caution.

- o The next best alternatives are Option 1 (peak/off -peak fares) and Option 3 (bus/rail fares).

  - Both raise revenue at around $4 per journey lost.

The distance-based options appear to have the lowest potential for revenue generation.

- o Both zonal options [2(a) and 2(b)] perform better than the graduated option [2(c)] in raising revenue at a rate of around $3 per journey lost, compared to around $2 per journey.

  - This probably reflects the fact that the graduated option was formulated as purely distance-based, and does not distinguish radial from local journeys.

FIGURE 9.2

INCREASE IN REVENUE ASSUMING THREE PERCENT LOSS IN JOURNEYS

OPTION	AVERAGE FARE INCREASE	CHANGE IN JOURNEYS m.p.a. (%)	CHANGE IN PSGR. MILES m.p.a. (%)	CHANGE IN REVENUE $ m.p.a. (%)	REVENUE PER JOURNEY LOST $	REVENUE PER PSGR. MILE LOST $
BASE OPTION	10%	-10.0 2.8%	-56.0 2.7%	22.0 6.9%	2.20	0.39
1. PEAK/OFF PEAK	17.6%	-10.5 2.9%	-51.7 2.6%	43.6 13.7%	4.15	0.84
2(a) RAIL ZONAL	13.8%	-10.3 2.8%	-65.9 3.4%	30.7 9.7%	2.98	0.46
2(b) SYSTEM ZONAL	19.9%	-10.1 2.8%	-160.1 8.3%	28.7 9.0%	2.84	0.18
2(c) RAIL GRADUATED	N/A	N/A	N/A	N/A	N/A	N/A
3. BUS/RAIL	17.9%	-10.3 2.8%	-61.1 3.2%	42.0 13.2%	4.08	0.69
4. PREPAYMENT	*	*	*	*	*	*

- If this market discrimination was added to the graduated option, it would no doubt improve its performance to that of the zonal structures.

o Of the two zonal fare options, Option 2(a) is to be preferred if ridership is defined in passenger-miles, since it raises revenue at $0.46 per passenger-mile compared to $0.18.

These results suggest that applying zonal fares to the whole system is not as effective as limiting zonal fares to the rail network only, and maintaining the existing flat fare on buses.

o This may be a reflection of the fact that rail journeys are generally more radial and the zonal structure exploits the lower fare elasticities in this market.

* Scores allocated to fare structure options under Criterion 1.

1	Peak/off-peak	=	5
2(a)	Rail zonal	=	3
2(b)	System zonal	=	2
2(c)	Rail Graduated	=	1
3	Bus-Rail	=	5
4	Max. Prepayment	=	(6)

The brackets indicate that the demand estimates of prepayment are subject to a higher level of uncertainty than the other estimates.

2. MAXIMIZE RIDERSHIP WHILE MAINTAINING EXISTING NET REVENUE

The options were evaluated to assess the potential for maximizing ridership while maintaining the existing net revenue. Fares were restructured in such a way that fare differentials were created that were consistent with the definition of each option.

- For instance, in the case of Option 1 (peak/off-peak), peak fares were raised while off-peak fares were reduced such that while ridership increased, revenue remained the same.
  - The results are shown in Figure 9.3 following this page.
- Options 1 and 3 are similar, increasing journeys by 5.1 and 6.3 million per year. These increases amount to around 1.4% - 1.7% increase on the base ridership.
  - In terms of passenger-miles, the increases are slightly lower; between 1.0% - 1.1%, indicating that the additional journeys generated are shorter than the base ridership.
- For Options 2(a) and 2(b), the definition of ridership is crucial. Both options increase journeys, but passenger-miles are reduced.
  - This implies that the increased number of journeys is more than offset by the reduction in their average journey length.
  - This situation demonstrates the need to be clear about the definition of ridership. The contrast between definitions is highlighted in Option 2(b) where the changes compared to the base are significantly larger than those in Option 2(a).
- Option 2(c) (rail graduated) shows the least potential for increasing ridership.

TABLE 9.3

RIDERSHIP CHANGES ASSUMING NO CHANGE IN REVENUE

OPTION	CHANGE IN JOURNEYS m.p.a. %	CHANGE IN PASSENGER MILES m.p.a. %	CHANGE IN REVENUE* m.p.a. %
1. PEAK/OFF PEAK	5.1 1.4%	21.5 1.1%	0.94 0.3%
2(a) RAIL ZONAL	2.7 0.7%	-8.9 0.5%	0.02 -
2(b) SYSTEM ZONAL	6.1 1.7%	-52.4 2.7%	0.50 0.2%
2(c) RAIL GRADUATED	0.32 -	13.0 0.6%	0.36 0.001%
3. BUS/RAIL	6.3 1.7%	20.1 1.0%	0.22 0.07%
4. PREPAYMENT	42.1 6.8%	N/A	0.06 -

  - Again, this is probably because the fare structure does not discriminate between local and radial markets and is based on distance alone.

  - The survey found little evidence of distance influencing sensitivity to fare changes.

- Option 4 (prepayment), ranks highest in its ability to generate additional ridership.

  - Although this must be treated with caution the intention of including these results alongside those of the alternative options is to provide an indication of the possible comparison in a common framework, if certain assumptions about prepayment are made.

The ability of prepayment to generate additional discretionary journeys, particularly in off-peak periods is reasonably well accepted. However, to date there has been very little hard evidence by which the effect can be quantified.

* Scores allocated to fare structure options under Criterion 2.

1	Peak/off-peak	=	5
2(a)	Rail zonal	=	2
2(b)	System zonal	=	3
2(c)	Rail graduated	=	1
3	Bus-Rail	=	5
4	Max. Prepayment	=	6

3. EASE OF IMPLEMENTATION

(1) Option 1 Peak/Off-Peak

This option was proposed by the CTA in 1986 and a considerable amount of planning was undertaken at the time. Many of the potential difficulties of implementation have therefore already been considered; none were expected to be insurmountable.

- o Given that the option would require very little new hardware or modification to existing equipment, the timescale for its introduction would depend upon the time required to plan the exact details of the system and to train the staff involved.

- o Good publicity and public information would be essential.

* SCORE: 5.

(2) Option 2(a) Rail Zonal

This option could be introduced before all station modifications are completed. Since the option does not require all stations to be gated to operate effectively, a phased program of installation would be possible. Stations undergoing modification would operate as open until the fare equipment was fully operational.

- o The first major hurdle to be negotiated would be the introduction of tickets.

  - Since none exist at present, this would be a radical change. Implementation would be necessary throughout the system on the same day.

  - Either station agent equipment or ticket vending machines would need to be in place at all stations prior to the change.

  - A system of checking passengers from the system on exit, whether manual or automatic, would also need to be completed before the change-over occurred.

  - One solution would be to ensure that all riders at least had a ticket on entry during the transition phase.

- o Implementation would be eased if a fare gate were available which could operate in a mode compatible with the existing gated arrangements. This would allow the existing fare system to be maintained while the new fare gates were being installed.

  - This would greatly facilitate the change-over at stations where space is restricted and there is insufficient space to accommodate the new gates alongside the existing fare equipment.

  - Such an approach would permit all the new fare gates to be installed prior to the change-over.

- o Implementation may be eased if the new facilities were initially operated with flat fares thereby avoiding the need to check on exit.

  - This would allow riders to become accustomed to the new method of entry before having to cope with different tickets and method of exit.

* SCORE: 3

(3) Option 2(b) - System Zonal

It is unlikely that zonal fares could be made to work effectively on the bus network in its existing configuration. Given the long standing tradition of flat fares, there would need to be a considerable transition period to allow for training of the CTA staff to enforce different fares and for the system to gain public acceptance.

- o Such a radical change to the method of charging would be more easily implemented in parallel with changes to the bus network so that revised fares could be charged for a different service.

- Given that changes of this type are of necessity long term, it follows that the introduction of distance-based fares in this way would only be implemented gradually.

o The necessary hardware requirements for implementing distance-based bus fares would be comparatively modest.

- The technology of bus ticket vending and validating equipment is now well proven. Buses could be readily equipped with the necessary equipment during their routine maintenance cycle.

* SCORE: 1

(4) Option 2(c) - Rail Graduated

Because all stations need to be gated and the extensive modifications necessary to achieve this, implementation would need to be phased over a number of years.

o The nature of the system is such that all stations would need to be converted before the new fare structure could be implemented and tickets issued.

o As with Option 2(a), the transition phase would be considerably eased if new gates could operate to be compatible with the existing system.

* SCORE: 2

(5) Option 3 - Bus/Rail Fares

Since there was a bus/rail differential fare as part of the 1986/7 fare structure, this option would be easy to implement.

o The only significant change would be the introduction of bus-only monthly and 14 day passes.

* SCORE: 6

(6) Option 4 - Maximum Prepayment

This option would extend the scope and range of monthly and 14 day passes. There would therefore be no difficulty in implementing the option alongside the existing cash fares.

- The advantage of phasing in the option in this way is that it would enable riders to become accustomed to alternative ticket types while still having the choice of the existing cash fares.
  - This would enable the CTA to evaluate public response to various ticket types and to tailor them to the needs of the market before full implementation.
- As riders became more familiar with this method of payment and less dependent on the availability of cash fares, it is hoped that the proportion paying cash would gradually decline.
- It is desirable that the need for transfers would decline such that they could be withdrawn without causing undue hardship.

* SCORE: 4

4. REASONABLENESS (PUBLIC ACCEPTABILITY)

(1) Option 1 - Peak/Off-Peak

The traveling public does not generally accept or understand why operating costs are higher in the peak. Indeed there is not even a complete consensus among transit operators that this is true.

- To many riders, the peak is associated with
  - Uncomfortable rides in crowded trains and buses
  - Gaps in service accompanied by anxiety of being late for work
  - Having to stand.

The fact that service frequency is generally significantly better in the peak is probably taken for granted rather than appreciated.

- o To many, being charged a higher fare for the dubious benefit of traveling in peak hours will be seen as adding insult to injury.
  - \- Although the majority of peak travelers will be employed and therefore better able to pay higher fares, this argument will not be considered as justification by the average rider.

* SCORE: 1

(2) Option 2 - Distance Based

To be charged more for traveling further is obviously logical and is consistent with the widely accepted view that the more one consumes, the more one should pay.

- o Although flat fares are both convenient for the transit operator, and simple to understand and widely accepted by riders, it does not follow that they are reasonable.
- o Flat fares substantially penalize short distance riders while subsidizing riders making long distance journeys.
  - \- For this reason, they distort consumers choice and the efficient allocation of resources.
- o To many, charging by distance is an inherently reasonable basis for a fare structure.

People who have made long term decisions regarding housing and employment location on the basis of a flat fare structure they have been led to believe is permanent may perceive distance-based fares as unreasonable.

- o Adequate publicity and phasing would be essential for this option to gain public acceptability.

Zonal fare options discriminate against those riders traveling to the Central Area.

- o This may be seen as exploiting the competitive position of transit in accessing the Central Area and be considered unreasonable.

The application of distance-based fares to rail only [Options 2(a) and 2(c)] is more concerned with the rationale for a bus/rail fare differential. This application is discussed in the next section.

* SCORE: 5

(3) Option 3 - Bus-Rail

Many transit properties charge higher fares for rail services than bus, particularly in European cities where the two transit modes often compete by serving common destinations.

- o Rail services are generally accepted as providing a higher quality service in terms of speed, reliability and comfort.
- o Rail services are more costly to provide due to the considerable capital investment required for the infrastructure.

In Chicago, the CTA rail services are seen as an integrated part of the public transport network and many journeys can only be reasonably made using bus and rail services.

- o It is estimated that around 30% of all journeys fall into this category.
- o This perception is reinforced by the philosophy of the grid layout of the network in which the bus services feed transit stations and do not attempt to duplicate rail routes.
  - The system of transfers also encourages this perception of an integrated network.

It could be argued that charging higher fares for rail is inconsistent with the concept of an integrated network, and is therefore unreasonable.

- Given that longer journeys tend to be more convenient by rail, charging higher fares on rail is an effective proxy for charging by distance.

  - In addition, access to the Central Area is generally quicker by rail particularly during peak hours.

For these reasons, it is considered that charging higher fares for the higher level of service provided by rail is seen as reasonable by most CTA riders.

* SCORE: 3

(4) Option 4 - Maximum Prepayment

This option effectively charges more for cash fares and penalizes those riders who are either unwilling or unable to make the necessary advance commitment to travel which prepayment calls for.

- Prepayment benefits the operator by reducing the number of fare transactions and the degree of cash handling.

  - To charge higher fares for paying cash may be seen as paradoxical, given that many traders offer a discount for cash. Higher cash fares may therefore be regarded as unreasonable by some riders.

- Prepayment by definition requires riders to pay a lump sum in advance and must therefore have sufficient funds to do so.

  - This is obviously more difficult for the poorer sections of the community. Since it may be the more affluent who can take advantage of large discounts obtained through bulk purchase, it could be argued that this is unreasonable. However, the CTA travel diary survey showed that pass purchase was not limited to higher income groups, suggesting this is not the case.

- o The less affluent are more dependent on and therefore committed to public transit.
  - Large discounts for bulk purchase of a commodity which they have no choice but to buy are therefore a distinct benefit to them.

Infrequent riders, who have other transport options available, but who nonetheless enjoy the opportunity of using public transit, may very well be prepared to pay a higher cash fare for this convenience.

* SCORE: 2

5. REVENUE PROTECTION

(1) Option 1 - Peak/Off-Peak

This option would involve little change from the existing system.

- o Station agents would need to sell and register the appropriate fare according to the time of day.
  - This would be best achieved by modifying the fare equipment to register fares automatically corresponding to the time of day.

At stations, turnstiles would need to be modified to operate only if the correct fare for the time of day had been registered.

- o On buses, the GFI farebox would need to be modified so that the machine would not accept registration of off-peak fares during peak periods.
  - If this modification proved uneconomic, an audit procedure would need to be implemented to check for off-peak fares being registered in peak periods by examining the data output from the GFI farebox which would need to discriminate between the peak and off-peak periods.

Fare evasion by riders would be unchanged from the existing system.

- There would be greater incentive to avoid paying peak fares but this in turn would be no more difficult during peak periods than at present given the higher levels on staff on duty.

* SCORE: 4

(2) Option 2(a) - Rail Zonal

This option would eliminate the present system of transfers and this would remove one source of existing fraud; any rider within the paid area would need to be in possession of a valid ticket.

- This would have two advantages in terms of revenue protection.
  - Any rider within the paid area without a ticket could only exit at a station where it was possible to negotiate the barriers or fare gates illegally. Since it would be difficult to be guaranteed making an exit in this manner, the incentive for riders to attempt to gain illegal entry to the paid area would be reduced.
  - The need for riders to be in possession of a valid ticket would provide a means of implementing a system of random ticket checking by roving inspectors.

All distance-based options would provide additional scope for fraud to that which exists for monthly passes though their reliance on tickets.

- However, in general, daily ticket-based transit fares are relatively low value non-cash transactions compared to other opportunities for fraud.
- Depending on the extent to which the open station concept was pursued, this option would rely to a large extent on the deterrent effect of random ticket inspections.

The option evaluated assumes 28 open stations. These are located where traffic is low and the level of revenue at risk is small.

- The vast majority of passengers would need to pass through a gate at one end of their journey or the other.

- Ticket inspectors would concentrate on checking those journeys which would not be subject to automatic check either by working at strategic points of the rail network or undertaking "spot" checks at open stations.

The philosophy of this kind of approach accepts that a certain level of fare evasion would occur, but this would be kept to an absolute minimum.

- The level of fraud would need constant monitoring to review the balance between open and gated stations.

  - The capital costs associated with ticket checking and fare evasion are viewed as interchangeable.

The success of this approach would depend on a change of attitude by riders. The CTA would need to convince riders that it was easier to pay the correct fare rather than run the risk of being caught.

- Ticket inspections need to be high profile.

- Successful prosecutions of fare offenders need to be well publicized and the credibility of the system vigilantly maintained.

  - If passengers perceive a low risk of being checked compared to the cost and inconvenience of stopping to buy a ticket, the system would fall into disrepute and deteriorate rapidly.

- On balance, it is felt that in the existing situation, it is doubtful whether such a penalty fare system could be made to work without considerable difficulty.

* SCORE: 2

(3) Option 2(b) - System Zonal

On bus services, all tickets would be checked on entry either automatically or manually by the driver.

- o Because riders need to be in possession of a valid ticket at all times throughout a journey, this would provide a means of checking for illegal riders who have entered via the rear door.

There would be a major opportunity for fraud for journeys which cross a zone boundary and where riders could travel into zones for which their ticket was not valid.

- o The design of zone boundaries in relation to the bus network will determine the scope for this kind of fraud.

- o Zone boundaries would need to take advantage of natural boundaries between traffic objectives and be easily identifiable to reduce disputes between staff and riders.

It is unlikely that this option would be fully successful with the present structure of bus routes. CTA's bus network is characterized by a large number of long routes, many of which could cross one or more zone boundaries wherever these are located.

- o Enforcement of the higher fares by bus drivers, ticket inspectors or both would be crucial.

- o In the longer term, enforcement could be eased by restructuring the bus network such that routes serve local traffic objectives including transit stations.

    - Longer routes which served more than one zone, could be converted to express services for which a surcharge would be applied corresponding to the multi zone fare.

    - Long routes could be spit into two or more, serving local communities.

Restructuring the bus network would only be worthwhile if it could be proven in terms of operating costs and fare revenue.

* SCORE: 1

(4) Option 2(c) - Rail Graduated

Many of the revenue protection aspects affecting the other distance-based options apply to this one.

- The deterrent effect of random ticket checks would not be necessary although these could be implemented as added protection against fare evasion.
  - Ticket inspectors could check that all riders were in possession of a ticket which contained at least the minimum value and that the rider had made a legal entry into the paid area.

This option would depend on automatic ticket checking by fare gates. These gates would sound an audible alarm and signal the station supervisor in the event of a rejected ticket. In this way, riders would be deterred from using invalid tickets.

This option would improve revenue protection compared to the existing situation because

- Cash handling would be reduced,
- Illegal entry to the system would be reduced both through better entry control and through the capability to randomly check riders.

* SCORE: 6

(5) Option 3 - Bus-Rail

Given that a fare differential between bus and rail was in place in 1986-87, there would be no basis for a change in fare evasion.

- As the fare differential increased, the incentive to avoid paying fares on rail, either by gaining illegal entrance to the system or through the illegal use of transfers would increase marginally.

* SCORE: 4

(6) Option 4 - Maximum Prepayment

This option would affect revenue protection in two major respects:

- The reduction in cash handling would reduce opportunities for theft of cash
- The elimination of transfers would prevent their fraudulent use

However, prepaid tickets do provide other opportunities for fraud.

- The tickets themselves can be forged and the incentive for manufacturing forgeries increases as the validity of the ticket increases.
- An additional type of fraud is the use of a prepaid ticket by more than one person.
  - There is a risk of over-emphasizing the extent of this kind of fraud.
  - The scope for passing tickets to other people is limited given that this can be inconvenient and impractical.

If the illegal use of prepaid tickets was found to be above tolerable levels, the introduction of photocards as described in Section VI (Option Development) would be recommended.

- Photocards provide an economical way of checking that a prepaid ticket is used by only one person.

- Although station agents and bus drivers often do not have the time or inclination to check the identity of riders, there is a strong psychological effect of the risk of being checked.

o Once a rider was caught attempting to present a false identification card, they would be vulnerable to successful prosecution for fraud.

It is considered that this option would provide a means of reducing fraud compared with the existing system.

* SCORE: 5

6. OPTION COST

The costs in terms of capital investment for station modification and fare equipment purchase and the revenue changes arising from the options are set out in Figure 7.1.

o For simplicity, the cost of each option is expressed as the average increase in cost in cents per fare collected compared to the existing system.

o These are shown in Figure 9.4, below.

FIGURE 9.4

INCREASE IN THE COST OF FARE COLLECTION

OPTION	INCREASE IN COST (Cents per Fare)
1. PEAK/OFF PEAK	0.01
2(a) RAIL ZONAL	2.04
2(b) SYSTEM ZONAL	3.32
2(c) RAIL GRADUATED	3.38
3. BUS/RAIL	0.12
4. PREPAYMENT	1.12

There is a marked contrast between the three distance-based options and the other options which can largely be achieved using the existing fare equipment.

- o The former require high capital investments for the large amount of fare equipment and station modification.

- o Under the criterion, the scores awarded to each option reflect the inverse of their costs.

7. REVERSIBILITY (RISK)

(1) Option 1 - Peak/Off-Peak

The costs associated with this option are estimated to be reasonably small.

- o Expenditure on the fare equipment would not be entirely abortive because the modifications necessary to define the time of day would provide additional useful management information.

  - Only the minor costs associated with training and publicity would be abortive.

There would be some adverse publicity associated with the reversal of a decision to apply peak hour fares but probably no more than that which occurs during any fare change.

* SCORE: 4

(2) Option 2(a) - Rail Zonal

This option would constitute a substantial risk associated with the large capital investment necessary for station modifications and purchase of fare equipment.

- o The fare structure is such a radical departure from the current system, it would be difficult to run a pilot study in a limited section of the rail network.

- o The introduction of zonal tickets would involve considerable investment in hardware and operational changes. If for any reason the system proved unworkable, much of this expenditure would be lost.

Adopting an open station approach would not constitute a lessening of the risk. Although this is a means of reducing the capital costs, it is nonetheless a sub-option of a fully gated arrangement.

- o If the level of fare evasion was unacceptable, the only solution would be to move towards a more gated solution.
    - The situation in Chicago is different from that in London which is currently implementing a system which will use some open stations. In London there is already a means of checking tickets on exit which provides a fall-back position if the level of fare evasion proves unacceptable.

Because there is no gradual means of implementing this option, the decision to adopt this option would require well substantiated evidence that the expected benefits would exceed the costs.

* SCORE: 3

(3) Option 2(b) - System Zonal

Option 2(a) is effectively a sub-option of this fully zoned system. This option would not be implemented unless the first phase in Option 2(a) had proved successful.

- o The capital cost of the fare equipment for buses would be modest compared to that for rail.

If the investment were phased to coincide with the essential equipment replacement program, much of the cost would not be abortive if the option were to be abandoned.

* SCORE: 2

(4) Option 2(c) - Rail Graduated

Most of the risk associated with implementing Option 2(a) would apply to this option which option could only be implemented in total.

- o The necessary fare gates are far more sophisticated than those required for the existing fare structure; they would only be of value if they could be designed to be compatible with the existing turnstiles should the decision be reversed.

Given the high capital costs involved, this option would carry the highest risk.

* SCORE: 1

(5) Option 3 - Bus-Rail

This option already existed in part under the 1986-7 fare structure.

- o The only costs required would be those associated with the introduction of an additional monthly and 14 day pass.
- o The introduction of a fare differential on passes could be deferred until it was shown to be absolutely necessary alongside the cash fare differential.

There would be little risk attached to this option.

* SCORE: 6

(6) Option 4 - Maximum Prepayment

Unlike the distance-based systems, this option would be ideally suited to careful phasing.

- o The nature of the option is similar to introducing a new product on the market while leaving the existing arrangements in place.
  - Any product found to be unpopular or unsuccessful in meeting its aims could be withdrawn at minimal expense.

The option would need to be implemented only so far as it proved justified.

- This would imply that the ultimate goal to eliminate transfers could be deferred as long as necessary.

- This would be a low risk option.

* SCORE: 5

8. EQUITY OF FARES

(1) Option 1 - Peak/Off Peak

Those minority riders who are unemployed and economically disadvantaged would benefit from this option by having the choice of traveling off-peak .

- Those who need to travel to search for work would spend less than they do now on public transportation.

- Those who are employed but nonetheless on low income, would suffer to some degree.

- This option would effectively subsidize those who need it most.

* SCORE: 6

(2) Option 2 - Distance-based

In Chicago, there is a considerable concentration of minority populations to the south and west of the city center rather than in or near the center itself (the general pattern in many US cities).

- This implies that, whereas in most US cities, charging by distance would benefit these groups, in Chicago, the impact on minority ridership would not be any different to the average.

* SCORE: 3

(3) Option 3 - Bus-Rail

There is some evidence to suggest that the proportion of minority riders is higher for local transit journeys than that for radial (ie CBD) journeys.

- o As the rail network is very much more oriented towards the Central Area than the bus routes which adhere to the grid pattern of streets, reducing bus fares relative to rail, would benefit minority and economically disadvantaged riders more than average.

- o The economically disadvantaged and minorities who are unemployed will have a lower value of time and therefore would be more inclined to tolerate the longer journey times provided by bus services.

* SCORE: 5

(4) Option 4 - Prepayment

The main drawback of prepayment is the need to make an advanced purchase which can be difficult for those on low income.

- o However, if the availability of prepaid tickets provide discounted travel for those prepared to commit themselves, this will directly benefit those economically disadvantaged and minority groups who tend to be more dependent on public transportation.

- o The results of the travel diary survey carried out by CTA indicated that pass purchase was distributed across all income groups rather than being concentrated in the higher income groups.

* SCORE: 5

9. SIMPLICITY

(1) Option 1 - Peak/Off-Peak

This option would be marginally more difficult to understand than the existing system. The basis for the fare differential would be straightforward. The aspects of the fare structure which may cause some difficulty would be the explanation and acceptance of the rules for defining the demarcation between peak and off-peak periods.

* SCORE: 5

(2) Option 2(A) - Rail Zonal

Distance-based fares are already applied on Metra services; the concept would not be alien to the Chicago area.

- o The zonal concept is an attempt to simplify distance-based fares by grouping large numbers of stations into three areas to minimize the number of different fares.

It should be possible for CTA staff and passengers to remember the fares without reference to a fare chart.

- o Fares are a function of not only the origin and destination station, but also the route used to travel between them.
- o Good public information would be necessary for visitors and other less frequent users.
- o The time limit imposed on single fares would also require clear explanation, although not dissimilar to the existing transfer rules.
- o The principal difficulty would be in explaining the rules governing the relationship between fares and zones.

* SCORE: 3

(3) Option 2(b) - System Zonal

In many respects, this option is similar in concept to Option 2(a).

- o However, including bus services introduces other complexities.
  - Because bus stops tend to be spaced at higher densities than transit stations, it is difficult to define zone boundaries which are easily understood by the traveling public.
- o In addition, the need to introduce the concept of a buffer zone to allow for short journeys adds to the complexities of the zone definition.

* SCORE: 2

(4) Option 2(c) - Rail Graduated

This option would apply a different fare for each different station pair; there would be a large range of different fares for the average rider to remember.

- o Nonetheless, regular users would be expected to know their own fare. All stations would need to display a fare chart indicating the fare to all destinations.
- o The concept of a stored value ticket including the need to add value in order to exit from the paid area on occasion, is reasonably complex and is far removed from what exists at present.
  - The arrangements for making a transfer to bus services would introduce a further complication.

* SCORE: 1

(5) Option 3 - Bus/Rail Differential

The only new concept would be the introduction of differential passes which would restrict bus passes to bus services only.

* SCORE: 6

(6) Option 4 - Maximum Prepayment

This option at least initially, is to introduce an additional range of products to the existing range of fares.

- This would inevitably increase confusion and it may be difficult for riders to be sure they had bought the ticket best suited to their own circumstances.

* SCORE: 4

10. MANAGEMENT INFORMATION

(1) Option 1 - Peak/Off-Peak Fares

This option would provide limited additional management information which could not be supplied by the existing fare equipment.

- The reallocation of keys on both GFI and VISIFARE equipment, would provide ridership by time of day.
  - This would be useful for service planning and would enable savings in data collection costs elsewhere.

The more detailed information concerning fares would enable better accounting of fare revenue.

* SCORE: 3

(2) Option 2(a) - Rail Zonal

The data capture which would be feasible in this option could provide considerable benefit under all categories of management information.

- o Marketing and Planning.

  - The system could provide good data regarding passenger movement patterns. This would enable the CTA to improve the planning and marketing of its services to increase its market share and business performance.

- o Financial Accounting.

  - The equipment would be capable of producing the necessary up to date data for fare revenue accounting. This would improve revenue control and savings in staff costs associated with this function. The efficient reporting of fare equipment failure would also reduce fare revenue losses.

- o Operation Control.

  - The availability of on-line information of passenger traffic and equipment failure would provide considerable benefit. Maintenance staff could be more efficiently deployed reducing down-time and passenger inconvenience. Early warning of problems arising in the system which could give rise to abnormal conditions at stations would allow remedial action to be taken quickly.

* SCORE: 5

(3) Option 2(b) - System Zonal Fares

In addition to improved information concerning the rail network, this option would provide better data covering bus services.

- o Electronic fare equipment could store information on journey patterns both by time of day and distance which, would be valuable for bus service planning.

- o There would be no on-line information since data would be down-loaded once the vehicles return to garages.

* SCORE: 5

(4) Option 2(c) - Rail Graduated Fares

The benefits of the other distance-based options would also apply to this system. However, the information collected would be considerably more comprehensive. For instance, the system could be capable of storing data providing station to station passenger flows by time of day.

* SCORE: 6

(5) Option 3 - Bus-Rail Fares

The only additional management information generated by this option would be that arising from differential pass sales. This would be useful in marketing and planning bus and rail services but only to a limited extent.

* SCORE: 3

(6) Option 4 - Maximum Prepayment

Increased use of passes is accompanied by a loss of distinction between journeys and rides taken on parts of a journey.

- o With cash fares the number of journeys can be identified by the number of fares sold.

- o However, the demand for different types of pass would provide information which would allow better identification of the various markets provided for by CTA services.

* SCORE: 1

11. OPTION EVALUATION VALUES

The previous sections discussed the options under the ten criteria developed within the evaluation framework. Scores have been awarded to each option based on the extent to which they achieve the aims compared to the base.

The next stage is to combine these scores to derive an overall value of each option. During this process of combination, the relative priority which the CTA decided to give each of the ten aims needs to be taken into account.

- o This is achieved by weighting each aim between 0 and 100. Those aims considered as the highest priority are assigned the largest weight.

- o The weights are allocated to each criterion are for illustrative purposes only. They represent a distillation of:

  - The outcome of discussions with a number of CTA Board members.

  - The results of the strategic tradeoff questionnaire completed by those Board members.

  - Interviews with a number of senior CTA personnel.

Figure 9.5, following this page, provides a summary of the scores awarded to the options under each criterion and a set of assumed weights to represent the level of priority attached to each aim. Total scores, both weighted and unweighted are shown at the bottom of the table.

- o This table clearly indicates that Options One, Three and Four have similar scores of around 17 to 18 and that therefore there is little to choose between them.

- o The distance-based options all have markedly lower scores ranging between 6 and 9. The difference between these scores and those for the other options is sufficiently large, that even a reassignment of priority in aims would not change their rank position.

FIGURE 9.5

OPTION SCORES

CRITERION	WEIGHT	OPT 1 PEAK/ OFF PEAK	OPT 2(a) RAIL ZONAL	OPT 2(b) SYSTEM ZONAL	OPT 2(c) RAIL GRADUATED	OPT 3 BUS/RAIL	OPT 4 PREPAY.	BASE
1. Max revenue, riders const.	80	5	3	2	1	5	6	0
2. Max ridership, rev. const.	80	5	2	3	1	5	6	0
3. Ease of implementation	20	5	3	1	2	6	4	7
4. Reasonableness	10	1	5	6	5	1	3	0
5. Revenue protection	25	4	2	1	6	4	5	4
6. Cost	80	5	3	1	2	6	4	7
7. Reversibility	20	4	3	2	1	6	5	7
8. Max rides by disadvant.	20	6	3	3	3	5	5	3
9. Simplicity	10	5	3	1	2	6	4	7
10. Management Information	5	3	5	5	6	3	1	0
Unweighted Scores		43	31	27	28	47	43	
Weighted Scores		16.8	8.95	8.8	6.1	18.1	17.6	

- o Comparing Options One and Three, the bus/rail option scores higher for implementation, understanding, and reversability. It is also less costly.

- o The peak/off-peak option ranks higher only on maximizing minority ridership. This ranking is robust to changes in priority of aims.

- o Option Four appears to do well, but the reliability of the demand estimates should be borne in mind when comparing these scores.

- o Comparing the distance-based options, both zonal options appear better than the rail graduated option. However, if revenue protection was assigned a much higher priority, this situation would change.

Figure 9.6 following this page, shows how each option scores against the existing situation, giving some indication of those which may be worth implementing.

- o Only Options One, Three and Four have positive scores implying that, as formulated, the distance based options would not be worth implementation.

- o The score for the zonal options becomes positive only if the priority assigned to reasonableness is considerably increased.

In conclusion, this evaluation shows that Options One and Three are the most worthwhile of the options considered. While Option Three appears to have the highest value, the difference from Option One is probably not significant.

- o Option Four also gives every indication of being very worthwhile with considerable potential for further development.

- o The distance based options do not appear worthwhile as they are presently formulated and would probably require an alternative approach before this situation was reversed.

FIGURE 9.6

OPTION SCORES RELATIVE TO BASE

CRITERION	WEIGHT	OPT 1 PEAK/ OFF PEAK	OPT 2(a) RAIL ZONAL	OPT 2(b) SYSTEM ZONAL	OPT 2(c) RAIL GRADUATED	OPT 3 BUS/RAIL	OPT 4 PREPAY.
1. Max revenue, riders const.	80	5	3	2	1	5	6
2. Max ridership, rev. const.	80	5	2	3	1	5	6
3. Ease of implementation	20	-2	-4	-6	-5	-1	-3
4. Reasonableness	10	1	5	6	5	1	3
5. Revenue protection	25	0	-2	-3	2	0	1
6. Cost	80	-2	-5	-4	-6	-1	-3
7. Reversibility	20	-3	-4	-5	-6	-1	-2
8. Max rides by disadvant.	20	3	0	0	0	2	2
9. Simplicity	10	-2	-4	-6	-5	-1	-3
10. Management Information	5	3	5	5	6	3	1
Unweighted Scores		8	-4	-8	-7	12	8
Weighted Scores		6.05	-1.8	-1.9	-4.6	7.35	6.9

* * * * *

The broad conclusions regarding the distance-based options and the other options are unlikely to change if the priority assigned to each aim were changed. The conclusions are reasonably robust to a range of alternative fare policies.

X. CONCLUSIONS

X. CONCLUSIONS

The conclusions may be grouped under two headings:

- o Implications for fares policy
- o Survey work and data analysis

1. IMPLICATIONS FOR FARES POLICY

The market segments adopted by the study for analysis were:

- o Peak versus off-peak
- o Radial (CBD) versus local (non-CBD)
- o Distance

Of these, only segmentation by peak/off-peak and radial/local displayed significant differences in sensitivity to fare change.

- o Distance alone was not significant except for journeys of up to two miles.

Although bus and rail services were not treated as separate markets, the analysis of ridership data revealed significant differences in sensitivity to fare change when applied to unlinked bus and rail trips. This suggested a further basis for differential fares. However, it is possible that rail could be acting as a proxy for distance and radial markets.

- o In terms of increasing demand, those fare structures which introduced price discrimination based on peak/off-peak and bus/rail differentials displayed the most potential.
- o The fare structure based on distance alone [Option 2(c) - Graduated Rail] did little better than the existing flat fare structure.

- o The zonal structures [Options 2(a) - Rail Zonal and 2(b) - System Zonal] offer greater potential than Option 2(c) by exploiting the Local/Radial market segments as well as distance.

- o Option 4, Maximum Prepayment offers considerable potential, particularly if the aim is to increase ridership rather than revenue.

  - Exactly how riders trade off pass fares against cash fares is complex, and it was difficult to model the mechanism which drives the take-up of prepaid tickets.

  - Nevertheless, this kind of fare structure does exploit aspects of the market not adequately addressed by more conventional cash fare structures.

Prepayment could also exploit market opportunities which are costly to approach using a cash-only fare structure. For instance, an element of distance or zonal charging could be introduced through zonal passes.

- o This could be additional to the main fare structure.

- o This would allow the approach to be tested in small stages at low cost and low risk.

It would be technically feasible to convert the CTA rail system to accommodate distance-based charging using automatic fare gates.

- o Although the costs appear large compared with those of the alternative options, they would not be unreasonable if set against the scale of investment associated with station modernization and renewal.

  - There would be many instances where the necessary station modifications could be incorporated in planned station redesign at very little extra cost.

Many of the stations where space is extremely limited, could be operated as open stations. However, there are doubts whether the necessary penalty fares system would be workable in Chicago.

The investment associated with installing fare gates in the distance based options could not be justified purely on the basis of the additional revenue generated.

Zonal or distance based fares on bus services would not be easy to implement without restructuring the bus network.

- o Given that the potential for increased revenue or ridership which these fare structures could raise is not particularly significant, restructuring the bus network for the fare structure alone would not be worthwhile.

In terms of other CTA fare policy goals, two issues stand out:

- o Revenue protection

- o The costs of cash handling. A move towards a cash-free fares policy would be worthwhile.

Apart from Option 4 which aims to maximize prepayment, there is little interplay between fare structure options and fare collection method.

- o Automation of fare collection is a means of improving existing systems rather than introducing different fare structures.

- o Prepayment would reduce the extent of cash handling and provide a means of eliminating the use of transfers.

  - This option would aid revenue protection.

The study found little evidence to suggest that any of the six options would affect the minority ridership significantly differently from other riders.

In meeting the aims established for the evaluation framework, Option 1 (peak/off-peak fares) and Option 3 (bus/rail) offer the greatest potential.

- o In addition, Option 4 (Maximum prepayment) could contribute significantly achieving the desired aims.

Since none of the options are mutually exclusive, the optimum fare structure is likely to be a blend of the best features of the charging methods identified.

- o The next stage in the development of the optimum fare structure would be to reconfigure the options to design out those features which lead to low scores in the evaluation framework and combine high scoring features in a single option.

2. SURVEY WORK AND DATA ANALYSIS

The survey method demonstrated the feasibility of estimating fares elasticity corresponding to relatively small sub-markets.

- o In this instance, no data existed at the required level of disaggregation to meet the needs of the study upon which alternative methods of analysis could have been based.
  - The method proved very appropriate.

The method was efficient in providing estimates of fares elasticity for the various sub-markets based on a relatively small sample.

- o The data collected exhibited a good level of reliability.
- o A rich data source was achieved which has considerable potential for further analysis of other influences on modal choice.

Both methods of data collection proved successful.

- o The use of self-completion questionnaires for the place of work enabled resources to be devoted to the more complex non-work travel survey.
  - Although for practical reasons, the interview questionnaire needed to be kept as short and as simple as possible, the data achieved was more than adequate in meeting the needs of the study.

The absolute values derived for fares elasticity appear to be higher than expected. (0.6 compared to 0.34)

- There are many different explanations for this, but it is essential to consider the exact nature of the elasticity identified.
    - This kind of approach leads to longer term elasticities, which tend to be higher than those based on short-term influences such as fare increases.
- Longer term elasticities take into account structural changes in travel patterns associated with land-use changes.

In the context of this study, the method adopted served its purpose in providing relative values of fares elasticity between each market segment.

- The concern of the study was to evaluate alternative fare structures which depends on relative rather than absolute values of fares elasticity.

As a demonstration study, the stated preference analysis adopted could be successfully applied to evaluate fare structure options in other American cities.

* * * * *

APPENDICES

APPENDIX A1

ANALYSIS OF EXISTING DATA SOURCES

APPENDIX A1

ANALYSIS OF EXISTING DATA SOURCES

The objective of this stage of the study was to explore all available existing data sources, and from them to extract journey information which would be the basis upon which the demand analysis tools would be formulated.

1. RIDERSHIP BY MARKET SEGMENTATION

The base journey information covered the following categories:

- o Peak and Off-Peak
- o Central Area and Non Central Area
- o Bus and Rail
- o Distance
- o Fare Type

(1) Total CTA Ridership

The total CTA ridership was defined in terms of the number of journeys made on the system per year.

- o A journey was defined as a linked trip comprising of one or more rides from an origin (such as home) to a destination (such as work).

An annual total was estimated from:

- o Cash fare data extracted from GFI fareboxes for bus journeys, and from VISIFARE ticket agent units for rail; it was assumed that each entering cash fare collected represented one journey.

- For journeys made using a monthly or 14 day pass, the estimate was based on the number of unlinked pass trips recorded by GFI and VISIFARE and then calculated using an average of 1.58 unlinked trips per journey derived form the 1986 CTA Trip Component Survey. This provided an annual total ridership as set out in Figure 1.

FIGURE 1

Journeys per Year 1986

(millions)

Fare Type	Journeys
Cash	228
Pass	132
Total	360

(2) Bus and Rail Ridership

The study divided CTA ridership into bus and rail.

- Rail journeys included those involving bus trips to and from rail stations.

- Bus journeys were those involving only bus trips

Cash journeys were split into these two modes by identifying the number of cash fares collected on buses and at stations. Bus/Rail journeys were estimated by extracting the number of rail differential fares collected by station agents. It was assumed that on average, an equal number of rail/bus journeys would be made in the opposite direction.

An alternative method used to estimate the bus/rail split was based on the 1979 Origin and Destination Survey data. Rail journeys were extracted from this data base by identifying all respondents who either received a ques-

tionnaire on rail or who gave rail as their onward mode of travel. (They were only supposed to complete a questionnaire received on the first leg of their journey).

Figure 2 below compares the modal split derived from both sources; the data correspond reasonably well. For this study, it was assumed that the proportions of journeys made on bus and rail pass were the same as those for cash journeys. However, if the 1979 Origin and Destination survey data were assumed to be reliable, it would imply that there was a bias of pass journeys towards rail.

Figure 2

Percentage Share of Bus and Rail (All-day) Journeys

Source	Bus	Rail
1979 Origin Destination Survey	54	46
1986 CTA Ridership Data (Cash Fare)	57	43

The 1986 CTA Trip Component Survey also gave similar results.

Figure 3 and 4 below show the total ridership broken down by mode both for a weekday and for a year.

Figure 3

Journeys Per Weekday

(thousands)

Mode	Cash	Pass	Total
Bus	431	237	668
Rail	324	179	503
	-----	-----	-----
Total	755	416	1171

Figure 4

Journeys Per Annum

(millions)

Mode	Cash	Pass	Total
Bus	133	77	210
Rail	95	55	150
	-----	-----	-----
Total	228	132	360

(3) Peak and Off-Peak Ridership

The bus and rail ridership were subdivided into peak and off-peak markets.

- o The peak was defined as all journeys made between 0600 to 0900 and 1600 to 1900 and primarily covers journeys to and from work.

- o The off-peak was defined as all other times, including weekday, midday and evenings, the weekends and holidays.

Weekdays were split into peak and off-peak based on the ridership hourly count published in OP-X85045 "Distribution of Ridership by Hours" dated 5th May 1985.

Weekend traffic was extracted separately from GFI/VISIFARE ridership data. Figures 5 and 6 show the resulting daily and annual modal splitting peak/off-peak.

FIGURE 5

DAILY RIDERSHIP BY MODE AND TIME PERIOD
(THOUSANDS OF JOURNEYS)

MODE	PEAK	OFF-PEAK	ALL DAY
BUS	322	345	667
Percent (%)	27.5%	29.5%	57%
RAIL	296	207	503
Percent (%)	25.3%	17.7%	43%
TOTAL	618	552	1171
Percent (%)	52.8%	47.2%	100%

FIGURE 6

ANNUAL RIDERSHIP BY MODE AND TIME PERIOD
(MILLIONS OF JOURNEYS)

MODE	WEEKDAY		TOTAL	WEEKEND TOTAL	ALL WEEK TOTAL
	PEAK	OFF-PEAK			
BUS	84	90	174	36	210
RAIL	78	54	132	18	150
TOTAL	162	144	306	54	360

(4) Geographical Distribution

The geographical distribution of the CTA ridership both in terms of travel patterns and journey lengths was estimated using both the 1979 Origin and Destination Survey and the 1980 Census Journey to Work Survey. Both sources provided data for the peak; whereas the study had to rely on the 1979 O & D survey data for the off-peak periods. As far as possible both sources were analyzed on a common basis for the purposes of establishing the level of consistency between sources.

To aid examination of the data, the CTA service area was divided into 12 zones (see diagram). The zone structure was adopted to identify 5 main corridors; north, north-west, west, southwest and south leading to two concentric central zones. The two inner most zones were identical to those adopted by the Chicago Area Transportation Study.

- Zone 1 was the Central Business District (CBD) bounded by Kinzie on the north, Harrison and the Chicago River on the west.
- Zone 2 included the remainder of the Central Area surrounded by North Avenue, Cermak and Ashland.
- Zones 3 to 7 covered the inner sections of the study area.
- Zones 8 to 12 covered the outer sections.
- Four of the five corridors were based on CTA rail services, while zones 6 to 9 enclosed the South-West corridor presently served by express bus services.

The area of analysis broadly corresponded to that of Cook County.

Data were extracted in two forms:

- An origin destination matrix based on the 12 zones defined above and,
- A distribution of journey distances based on mile bands.

These data were divided by mode and, from the 1979 O & D survey data, by the four periods of the day - the morning and evening peaks, and the midday and evening off-peak periods.

The journey matrices were then analyzed in three markets.

- A radial market, including all journeys either starting or ending in the Central Area

- A local market including all journeys both starting and ending outside the Central Area

- All journeys of less than 2 miles. Walking would be a competitive mode up to this distance effectively introducing a separate market.

Figures 7 and 8, following this page, show the relative size of these markets for bus and rail and for the two time periods both with and without the 2 mile market separately identified.

These tables provide an insight into the relative sizes of the various markets adopted.

- For rail, the radial market dominates, reflecting the good access to the Central Area relative to other destinations.

- For bus, there is less emphasis on radial movement and local travel dominates in the off-peak.

- Considering all CTA services, the radial market represents 56% of the total falling to 42% in the off-peak.

Figure 8 demonstrates the significance of the short journey market.

- For off-peak bus journeys, 35% are less than 2 miles, whereas, for peak rail journeys, this proportion falls to 11%.

Once the short journeys have been extracted, the dominance of radial trips in all markets is highlighted.

FIGURE 7

WEEKDAY JOURNEYS BY MARKET SECTOR (PERCENTAGES)

MODE	BUS		RAIL		CTA	
	PEAK	OFF-PEAK	PEAK	OFF-PEAK	PEAK	OFF-PEAK
CENTRAL	9	10	3	5	6.1	7.7
RADIAL	49	37	63	50	56.0	42.1
LOCAL	42	53	33	45	37.9	49.7
TOTAL	100%	100%	100%	100%	100%	100%

Figure 8

WEEKDAY JOURNEYS BY MARKET SECTOR Including 2 Mile Distance Market (PERCENTAGES)

MARKET =/> 2 MILES	BUS		RAIL	
	PEAK	OFF-PEAK	PEAK	OFF-PEAK
= or > 2 MILES				
CENTRAL	0.2	0.2	0.2	0.2
RADIAL	45.6	33.3	61.6	48.1
LOCAL	27.4	30.4	26.3	33.3
< 2 MILES	26.6	36.1	10.9	18.1
TOTAL	100%	100%	100%	100%

- For peak journeys over 2 miles, those to the Central Area dominate journeys to other destination by more than 2 to 1.

Figures 9 and 10, following this page, show the distribution of journeys by corridor for the peak and off-peak radial markets.

- These figures also compare the 1979 Origin-Destination Survey results with the 1980 Census.
  - The alternative data sources correspond within about 3 percentage points.
  - Larger discrepancies emerge once the markets are examined at mode level.

As expected, the North and South markets dominate, contributing about 60% of the total both in the peak and the off-peak.

- The remaining three corridors are approximately of equal size for the peak but have uneven distributions for the off-peak.
  - However, these surveys were conducted before the O'Hare extension was opened, which would have increased the relative importance of the North-West corridor.

(5) Distribution of Journey Length

The data from the 1979 Origin and Destination Survey were extracted by one mile distance bands for bus and rail, and for the four periods of the day. Figures 11 through 14, following this page, show these distributions.

Figure 15, below, compares the average journey length by mode and period. This table shows that on average, rail journeys are approximately 2 miles longer than bus journeys, and that peak journeys are about one mile longer than off-peak journeys.

FIGURE 9

PEAK JOURNEYS TO THE CENTRAL AREA
(PERCENTAGES)

	CTA		BUS		RAIL	
	1979 O&D	CENSUS	1979 O&D	CENSUS	1979 O&D	CENSUS
Inner North	25		31		18	
Outer North	8		4		11	
Total North	33	30	35	27	29	36
Inner North West	12		9		15	
Outer North West	1		1		1	
Total North West	12	15	10	10	16	22
Inner West	13		12		14	
Outer West	1		1		1	
Total West	14	18	13	17	15	19
Inner South West	10		12		8	
Outer South West	3		3		3	
Total South West	13	9	15	14	11	8
Inner South	20		21		20	
Outer South	8		7		10	
Total South	28	26	28	31	30	19
TOTAL	100%	100%	100%	100%	100%	100%

FIGURE 10

OFF PEAK JOURNEYS TO CENTRAL AREA

	CTA	BUS	RAIL
	1979 O&D	1979 O&D	1979 O&D
Inner North	26.2	33	20
Outer North	6.1	3	9
Total North	32.3	36	29
Inner North West	12.1	10	14
Outer North West	0.5	0	1
Total North West	12.6	10	15
Inner West	15.3	13	17
Outer West	0.6	0	1
Total West	15.9	13	18
Inner South West	6.5	8	6
Outer South West	1.7	1	2
Total South West	8.2	9	8
Inner South	23.5	26	21
Outer South	7.6	6	9
Total South	30.1	32	30
TOTAL	100.0	100	100

FIGURE 1.1

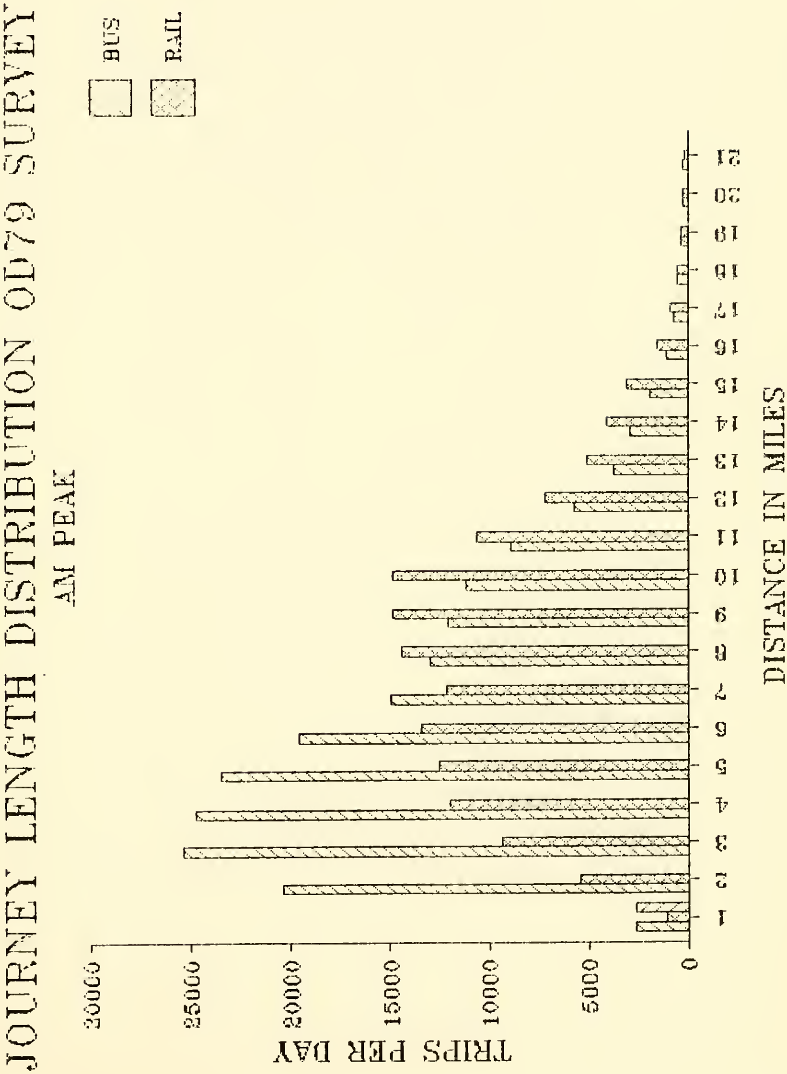
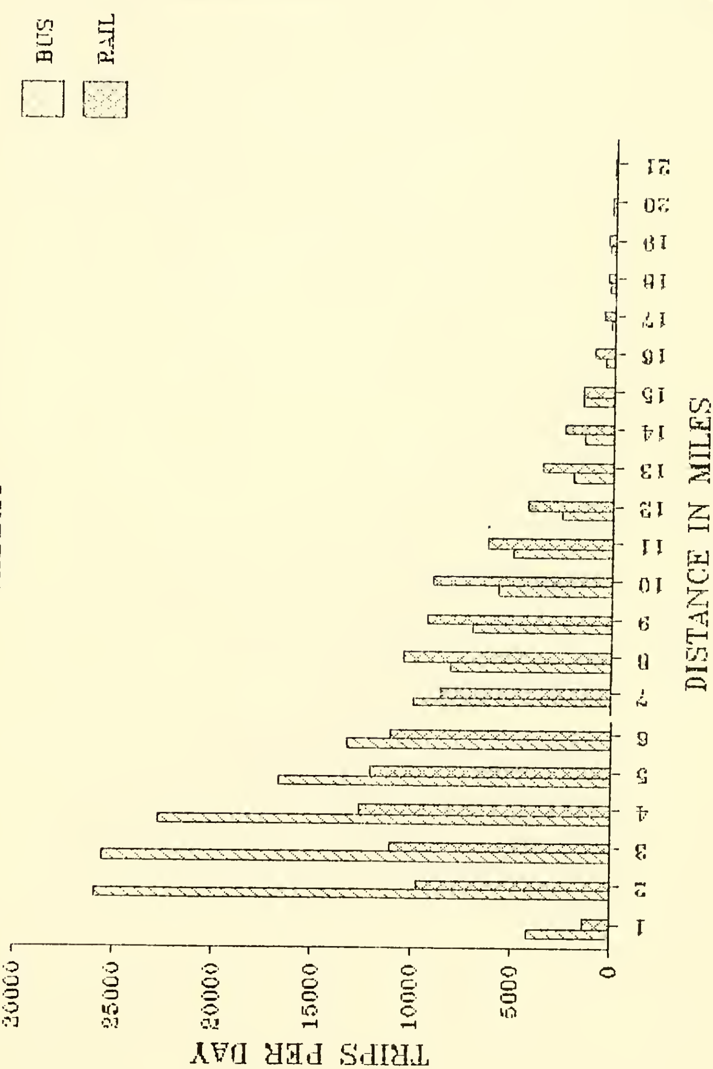

JOURNEY LENGTH DISTRIBUTION OD79 SURVEY
AM PEAK
BUS
RAIL
TRIPS PER DAY
0
5000
10000
15000
20000
25000
30000
DISTANCE IN MILES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

FIGURE 12

JOURNEY LENGTH DISTRIBUTION OD79 SURVEY

MIDDAY



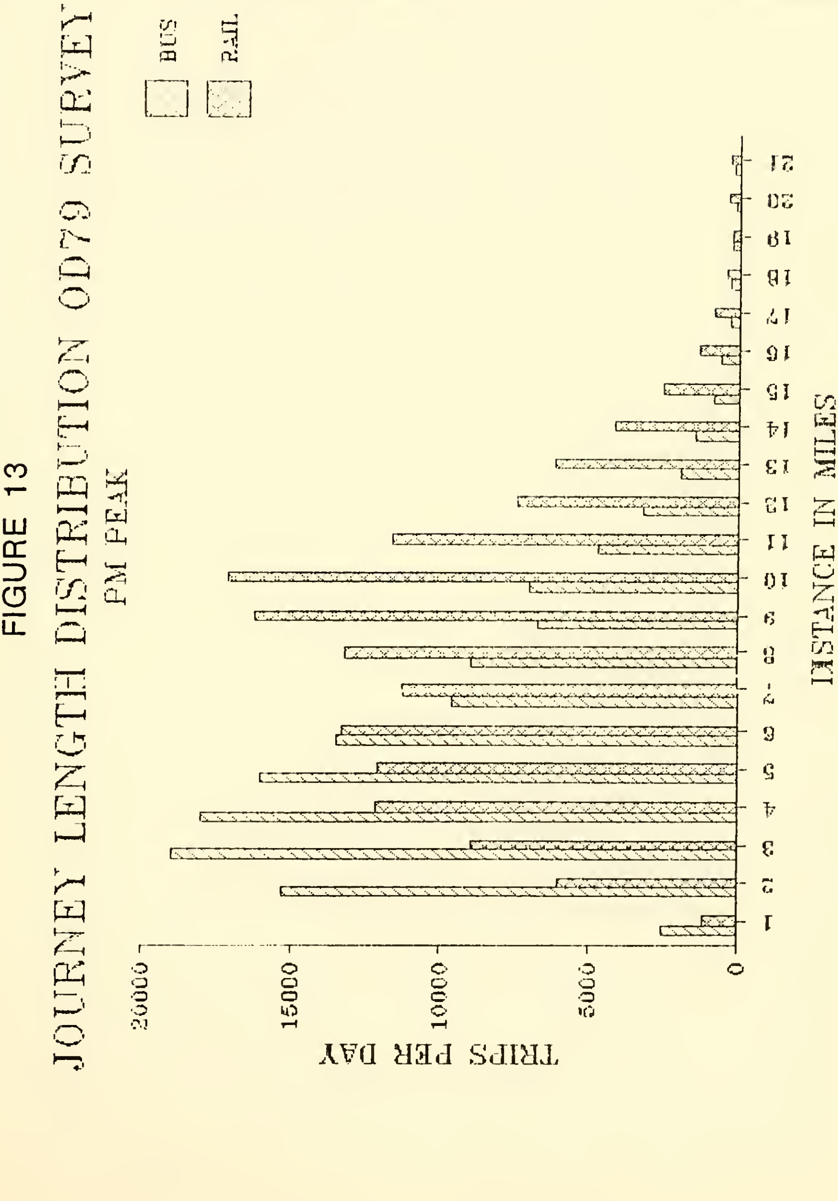


FIGURE 13
JOURNEY LENGTH DISTRIBUTION OD79 SURVEY
PM PEAK
BUS
RAIL
TRIPS PER DAY
0
5000
10000
15000
20000
DISTANCE IN MILES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

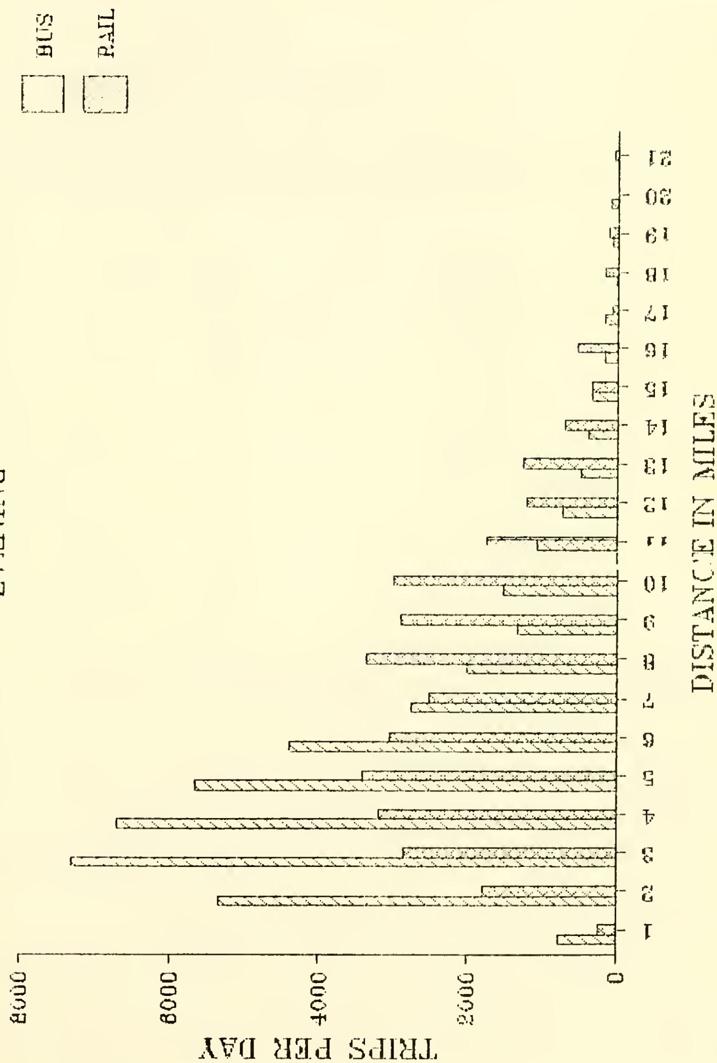


FIGURE 14
JOURNEY LENGTH DISTRIBUTION OD79 SURVEY
EVENING

Figure 15

<u>Average Journey Length</u>

Figures in brackets are from 1980 Census (Work Travel Only).

Time of Day	Bus	Rail
Morning Peak	5.8 (5.8)	7.5 (8.0)
Evening Peak	4.9	7.7
Peaks	5.5	7.6
Midday	4.4	6.1
Evening	4.4	6.5
Off-peak	4.4	6.2
All day	4.8	6.7

One curious feature of these figures is that the average bus journey in the morning is almost one mile longer than in the evening.

- o A possible explanation for this difference is that some riders may use bus to travel to work and rail for the homeward journey, particularly in the North corridor where an express rail surcharge is only charged in the morning.

Figures 11 to 14 display a similar pattern; bus journeys have a much sharper peak around 2 miles compared with rail journeys which have a flatter, more even distribution.

- o Both morning and evening peak rail journey lengths rise gradually to a maximum around 9-10 miles (eg 79th - 87th Streets), after which there is a steep decline.

Figure 16 compares the average journey lengths for each of the three markets.

- o Radial trips are about 2 miles longer on average than local trips, for both bus and rail journeys.

It is surprising that there is so little difference in radial journey length between bus and rail.

- o The average radial bus journey is 6.4 miles, which reflects the bus traffic carried by the express services operating on routes such as Lake Shore Drive and Archer.

The figure also shows average journey length for the morning peak compared with the corresponding averages form the 1980 Census data.

- o This shows a very close correspondence of the two data sources for radial journeys but a discrepancy of 1.7 miles for local rail journeys.

The difference may be explained by the difference in definition of rail journeys adopted by the two surveys. The Census defined rail journeys as those where rail was the principal mode and would, therefore, exclude bus journeys with a short rail stage. Long bus/rail journeys could have been excluded form the rail journeys in the census data, but included within the 1979 Origin and Destination Survey data. This type of journey is probably more frequent for local rather than radial market given that many journeys depend on bus rather than rail routes.

Figures 17 to 19 compare the journey length distributions extracted form the 1980 Census and the 1979 Origin and Destination Survey data. In the case of local bus journeys, a comparison is not meaningful because the 1980 Census data included journeys by PACE in Cook County. This therefore is not shown.

Figures 17 and 18 show close correspondence between the two data sources.

- o Both the average journey lengths and the overall shape of the distributions are very similar.

Figure 16

AVERAGE JOURNEY LENGTH BY MARKET
(MILES)

MARKET	ALL DAY			MORNING PEAK		
	BUS	RAIL	CTA	BUS	RAIL	CTA
CENTRAL (1980 census)	1.4	1.5	1.4	1.4 1.7	1.5 2.0	1.4 1.8
RADIAL (1980 census)	6.4	7.8	7.1	6.5 6.9	8.0 8.1	7.1 7.3
LOCAL (1980 census)	4.1	5.6	4.7	4.3 5.0	5.9 7.6	4.7 5.3
TOTAL (1980 census)	4.8	6.7	5.7	5.1 4.5	7.0 7.9	5.7 6.4

DATA EXTRACTED FROM 1979 O & D SURVEY

FIGURE 17

JOURNEY LENGTH DISTRIBUTION AM PEAK

RADIAL RAIL JOURNEYS

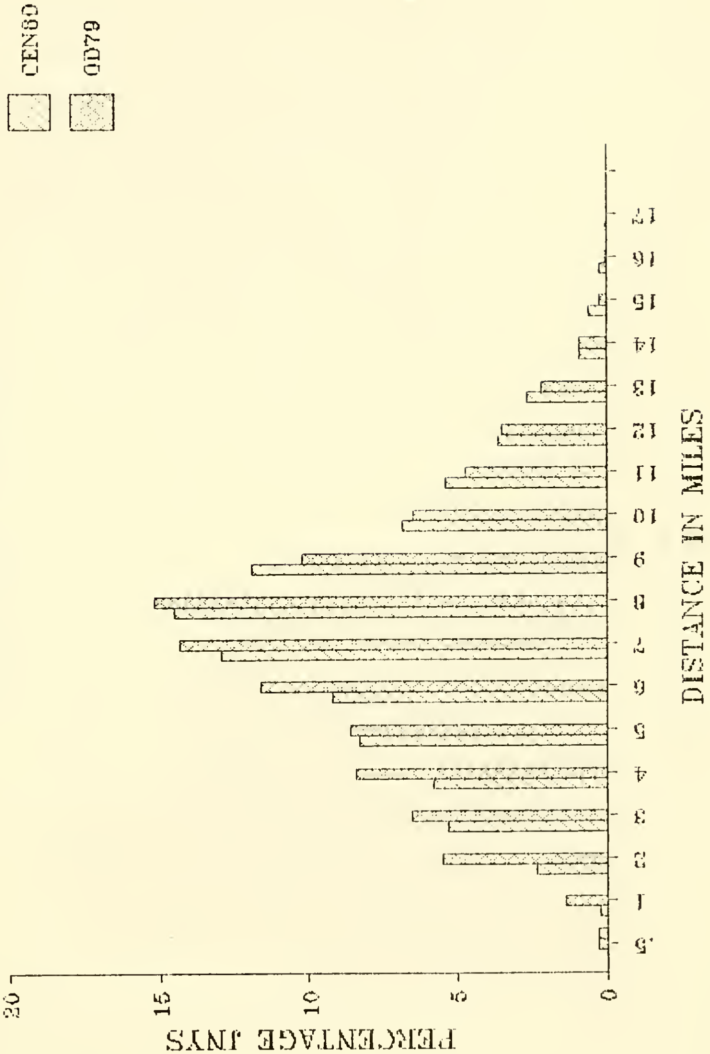


FIGURE 18

RADIAL BUS JOURNEYS

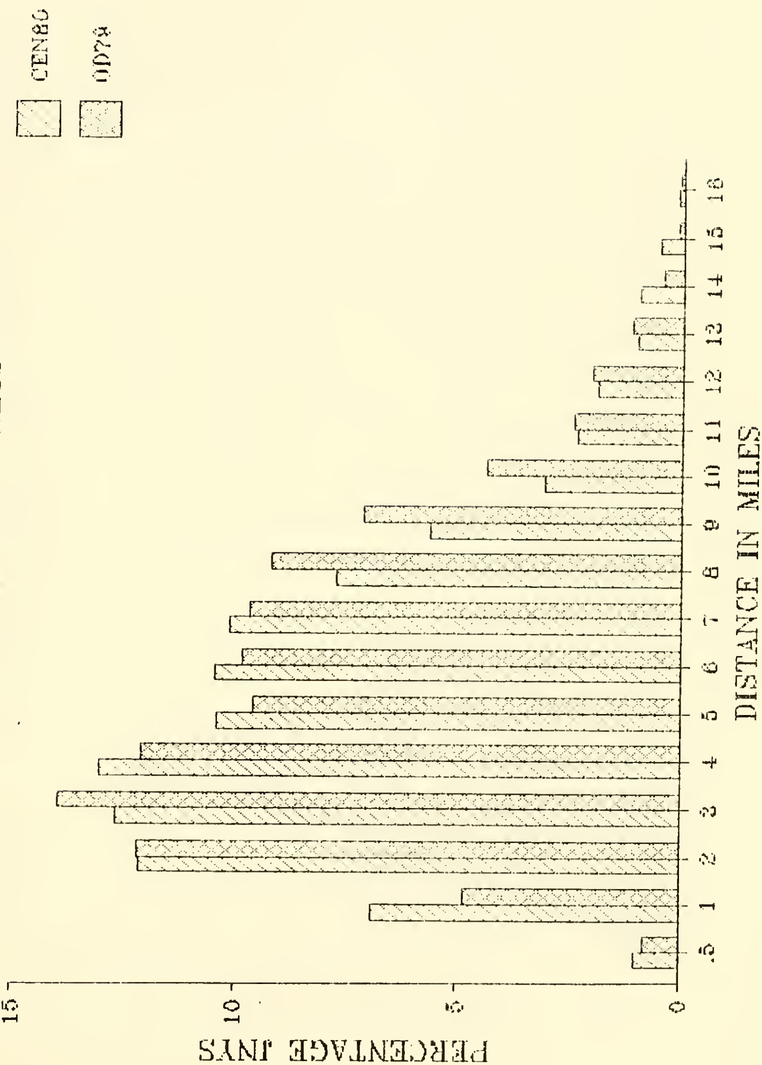
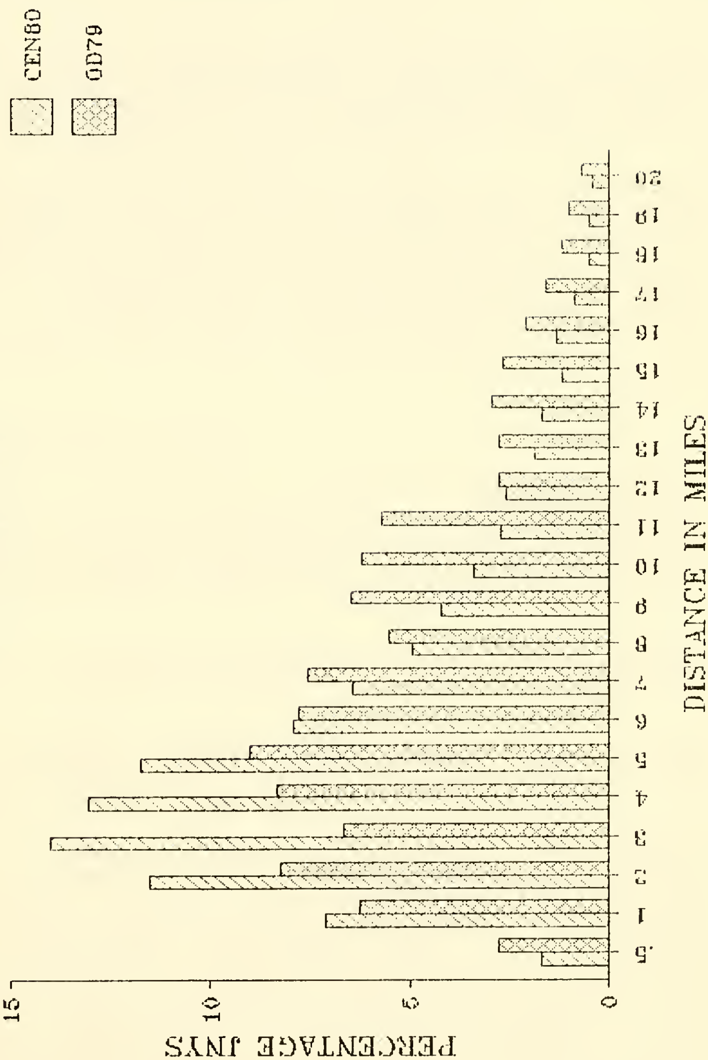


FIGURE 19

JOURNEY LENGTH DISTRIBUTION AM PEAK

LOCAL RAIL JNYS



- There is a striking difference between the bus and rail journey distributions, a sharp peak around 2-3 miles followed by a plateau up to around 8-9 miles for bus journeys and a pronounced peak around 7 miles followed by a sharp reduction for rail.

Figure 19 shows that there is a difference in both average journey length and shape of the distribution for local rail journeys. The distribution from the 1979 Origin and Destination Survey has a sharp peak around 3 to 4 miles, whereas, the distribution form the 1980 Census is much flatter. It is likely that a number of bus/rail journeys in the 2 to 5 mile band were defined as bus journeys in the 1980 Census.

2. CTA'S COMPETITIVE POSITION

The estimate the sensitivity of CTA's ridership to fare changes, data on car journeys were also extracted from the Census information so that an insight into the relative competition in each of the markets adopted could be gained. These data included all journeys made to work by car either as a driver or passenger.

Figures 20 to 22 show the share of the total travel market (excluding walk) attracted to CTA services for the radial and local markets.

- CTA services attract their highest share for the radial peak market (60%) and lowest share for the local off-peak market (20%).

- If the CBD is considered in isolation, CTA's market share rises to 77%, whereas for the Central Area excluding the CBD, the market share falls to 52%. This highlights the difference between the two zones contained within the Central Area. Within the Loop, car parking is limited and costly. CTA services provide good access to this area, particularly by rail, and enjoy a healthy competitive position. In other parts of the Central Area, parking is more readily available. In addition, rail availability is reduced so that a greater proportion of journeys made by CTA services are provided for by bus.

Figure 22 shows the relative competitive position of CTA services within the various corridors. It is interesting to note that in the peak, CTA attracts a higher share for the outer zones compared with the inner zones. Overall, there is little variation between corridors.

Figure 20

Mode Shares for Peak Period by Market

Mode	Radial	<2	Local	Central	Total
Bus	27	19	18	14	22 (25)
Rail	33	7	16	17	20 (19)
Car	40	74	65	69	58
Total	100	100	100	100	100

Figure 21

Mode Share for Off Peak by Market

Mode	Radial	<2	Local	Central	Total
Bus	30	12	12	10	15
Rail	26	4	8	4	9
Car	43	84	81	86	76
Total	100	100	100	100	100

Figure 22

Percentage of Total Journeys to Central Area by Transit

Area	Peak	Off-Peak
Inner North	73	56
Outer North	70	29
Inner North-West	60	61
Outer North-West	84	32
Inner West	66	61
Outer West	91	25
Inner South-West	66	76
Outer South-West	74	78
Inner South	61	58
Outer South	56	32

Figure 23 shows the radial market for the journey to work (from the 1980 Census data).

- o Car and rail have a similar distribution with a peak around 9 miles, but cars have a larger share of the market and a slightly longer average journey length. Bus has a much more skewed distribution, with a peak around 6 miles.

Figure 24 shows the dramatic difference between local and radial car journeys. Whereas radial journeys are evenly distributed over the 1 to 18 mile distance bands, local journeys have an extreme peak around 2 to 3 miles. This is in marked contrast to the distribution for transit shown in Figure 25.

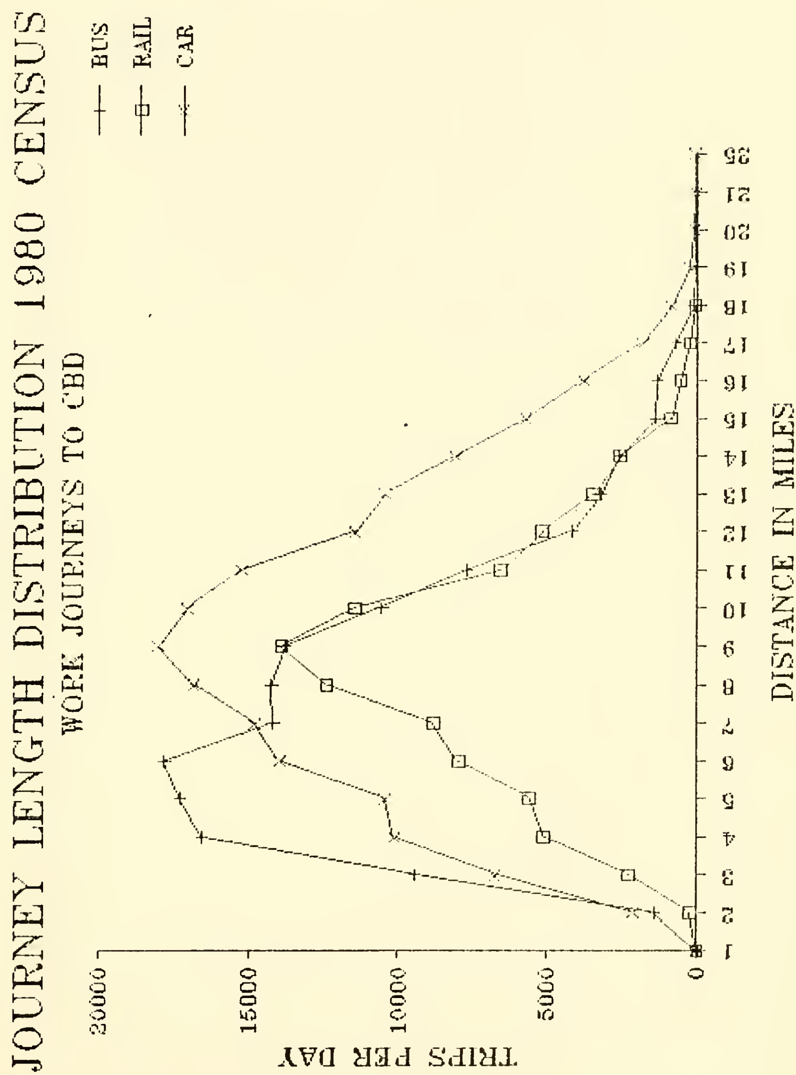


FIGURE 23
JOURNEY LENGTH DISTRIBUTION 1980 CENSUS
WORK JOURNEYS TO CBD
BUS
RAIL
CAR
TRIPS PER DAY
0
5000
10000
15000
20000
DISTANCE IN MILES
1
2
3
4
5
6
7
8
9
10
11
12
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16
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18
19
20
21
25

FIGURE 24

JOURNEY LENGTH DISTRIBUTION NON WORK

AUTO

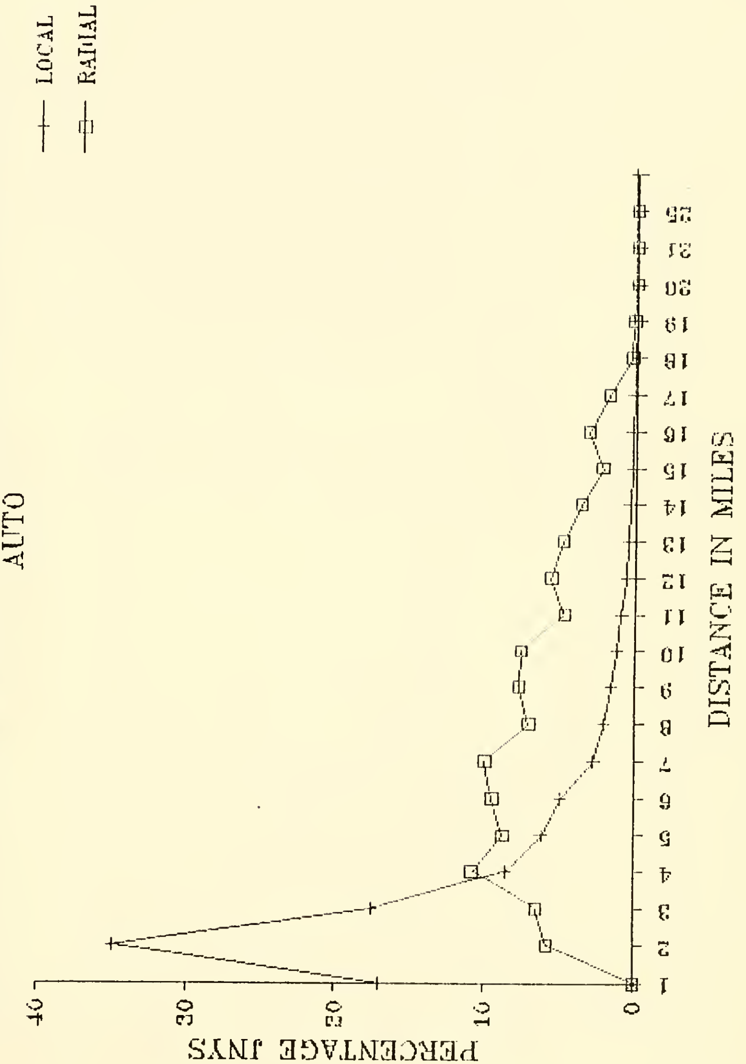
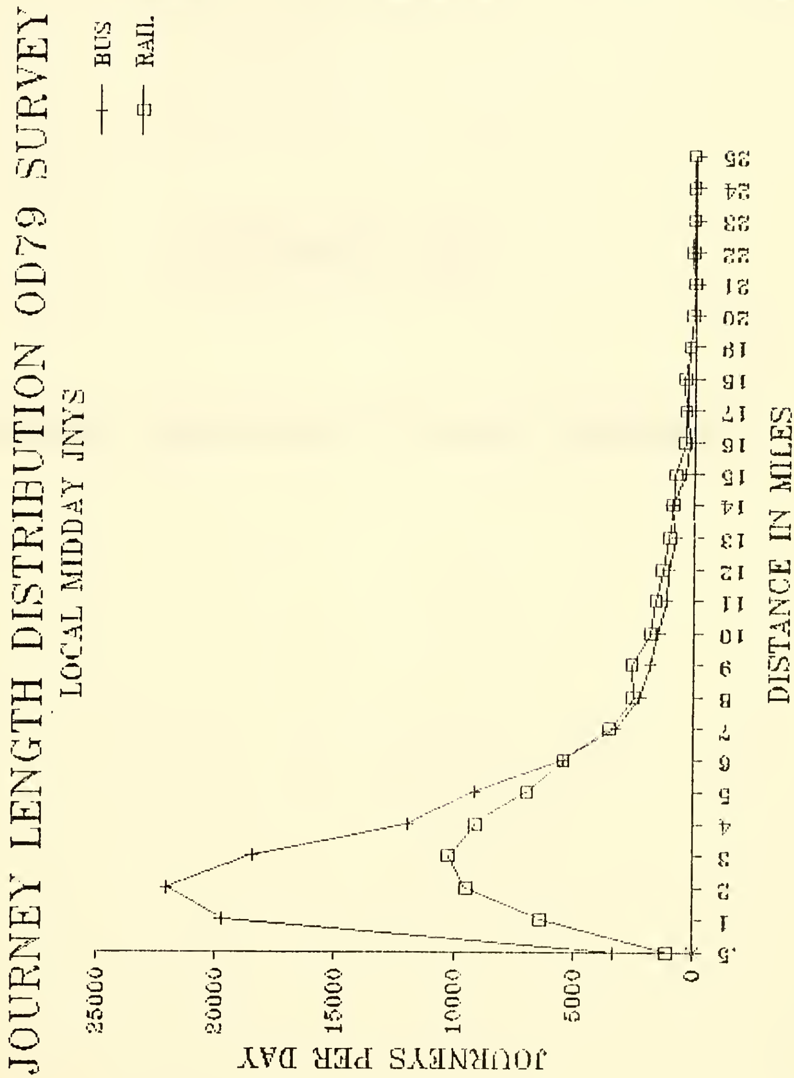


FIGURE 25


JOURNEY LENGTH DISTRIBUTION OD79 SURVEY
LOCAL MIDDAY JNYS
BUS
RAIL
JOURNEYS PER DAY
0
5000
10000
15000
20000
25000
DISTANCE IN MILES
.5
1
2
3
4
5
6
7
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APPENDIX A2

RIDERSHIP RESPONSE TO FARE CHANGES

APPENDIX A2

RIDERSHIP RESPONSE TO FARE CHANGES

Fare revisions and responses to them provide a valuable source of data for analyzing demand behavior and deriving elasticities to predict the outcome of future revisions. The most useful indicators are revenue and passenger trips corresponding to the periods before and after a fares revision. Ideally, the information would be disaggregated between major modes and/or ticket types.

This section reviews:

- o the recent fare revisions in Chicago
- o the annual CBD cordon passenger counts, and
- o elasticity estimates from the recent CTA fares revisions

1. RECENT CTA FARES REVISIONS

Since 1980 there have been three fares increases with the first two very close together. Figure 1, following this page, details the fares increases by the four main ticket types.

Each increase reflects different policy aims:

- o January 1981
  - A relative reduction in pass price;
  - A 16% pass price rise compared with 33% for cash fares.

FIGURE 1

CTA FARES INCREASES 1980-1986

DATE OF INCREASE	PASS $/MONTH	BUS $	RAIL $	TRANSFER $	TOTAL % CHANGE
		PRICES			
1980 - Base	30.00	0.60	0.60	0.10	
Jan 1981	35.00	0.80	0.80	0.10	
- % Change	16%	33%	33%	28%	30%
June 1981	40.00	0.90	0.90	0.10	
- % Change	14%	12%	12%	11%	12%
Jan 1986	46.00	0.90	1.00	0.25	
- % Change	15%		11%	18% *	18%

Notes:

1. Percentage Change is the percentage increase on the previous fare.
2. * Increase in transfer price was 25% for bus/rail and 15% for rail/bus.

FIGURE 2

DEMAND EFFECT OF FARES INCREASES (UNLINKED TRIPS)

DATE OF INCREASE	PASS	BUS CASH	RAIL CASH	PASS & CASH BUS	PASS & CASH RAIL	TOTAL	BEFORE & AFTER PERIOD
	TRIPS UNLINKED '000s						
Jan 1981	46	195	59	230	70	300	First half 1980/1981
Inrease	+23	-32	-7	-15	-1	-16	
% Change	50%	-16%	-12%	-6%	-1%	-5%	
June 1981	52	110	34	150	46	196	Second half 1980/1981
Inrease	-10	-4	+1	-12	-1	-13	
% Change	-20%	-4%	2%	-8%	-2%	-7%	
Jan 1986	164	304	107	428	147	575	Feb. 1985 Feb. 1986
Inrease	+35	-48	-16	-21	-8	-29	
% Change	22%	-16%	-15	-5%	-7%	-5%	

- June 1981
  - A slight increase in pass price;
  - 14% compared with cash fares, 12%.
- 1986
  - No change in bus fares;
  - The pass increase (15%) is higher than rail (11%);
  - The bus/rail transfers (25%) increase is more than the rail/bus (15%)

The effect on demand is shown in Figure 2, on the previous page.

- In January 1981, there was a big increase in pass take-up due to its relative decrease in price.
  - Bus/rail cash trips dropped by 16% and 12% respectively. It is likely that many of these passengers switched to using passes.
- Following the small relative increase in pass price in June 1981, usage dropped temporarily by 20%.
  - Bus trips fell by 4% and rail journeys showed a slight increase (2%).
  - The transfer add-on remained constant at 10 cents; this made transfer trips the cheapest relative deal after this fares revision.
  - It is likely that many pass users moved back to using transfers.
- By 1986, pass usage was back to its pre-June 1981 level and received a further boost in 1986 when rail transfers increased by 25% compared with 15% for passes.

2. PASS USE SINCE 1980

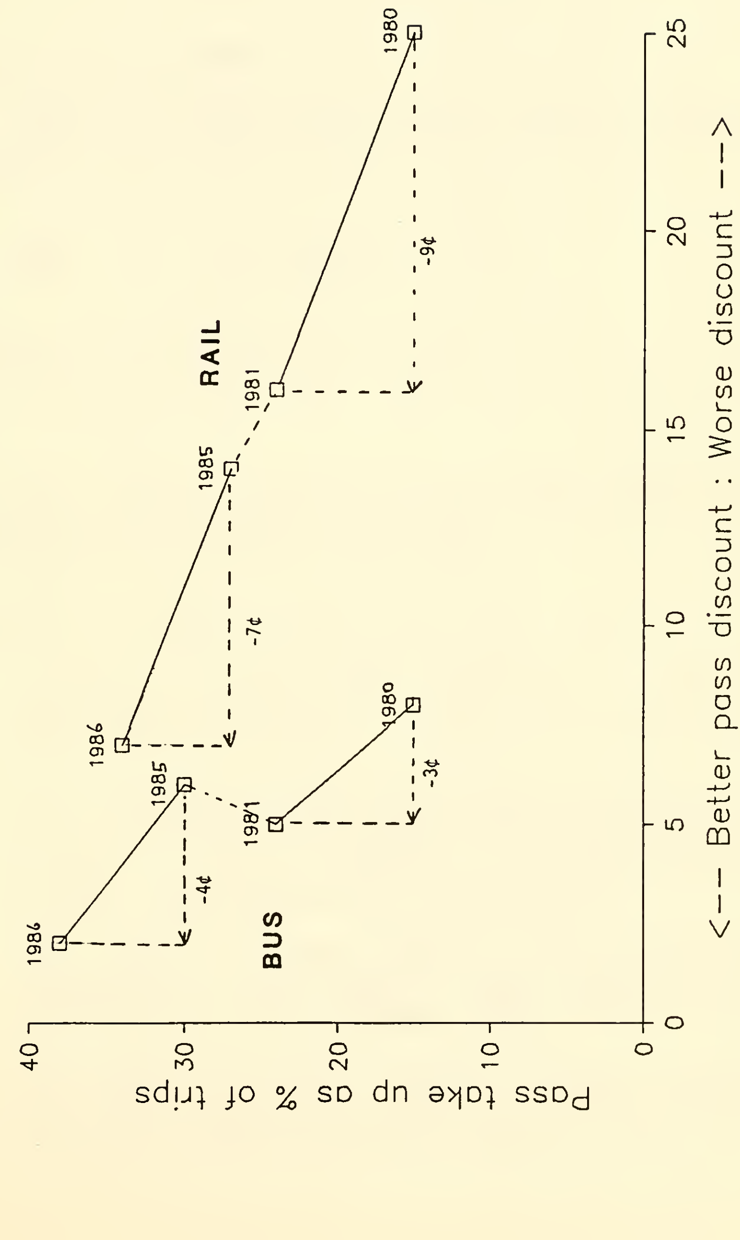
Pass take-up (share of unlinked rides by pass) is sensitive to the relative cost per trip of passes compared to cash. This was reflected in the changes following the fares revisions in Chicago since 1980.

- o Figure 3, following this page, illustrates graphically how take-up responded to relative changes in the discount of passes compared to cash fares.
  - The x-axis is the change in discount per unlinked trip. This was calculated at each fares level as the difference between pass receipts per unlinked trip and each cash price.
- o The January 1981 revision increased the pass discount by about 4 cents from 3 to 7 cents.
  - This increased take-up from about 15% to about 24% on both modes.
- o The effects of the mid 1981 revision was less marked as passes become slightly more attractive to rail travelers while their value compared with bus was unchanged.
  - A slight drop in pass use occurred, but by 1986 it had increased again to about 25%.
- o The 1986 revision improved the pass discount by 4 cents to 16 cents.
  - There was a further substantial increase in take-up to about 33%.

Clearly demand for passes among CTA users is sensitive to the discount relative to cash fares. CTA can exploit this demand to achieve policy objectives in ticketing and fares.

FIGURE 3. PASS TAKE—UP

(Relative discount measured vs. cash fares)



3. ELASTICITIES OF DEMAND

The behavioral changes have been used to derive fare elasticities, simply by relating the change in demand for trips (T) to the change in fares level (F), ie

$$\epsilon = \frac{(T1 - To)/To}{(F1 - Fo)/Fo}$$

Thus if a 3% trip loss follows a 10% fares increase, elasticity is estimated at -0.3.

Figure 4, following this page, gives the relevant data and results.

The fares increase is the overall CTA price increase, but the figure for 1986 is broken down to reflect the large discrimination between bus and rail. Trip losses are given by mode as are the elasticities (to trip-price ratios).

The ratio of receipts gain: price increase was surprisingly consistent over the three increases (0.63, 0.66, 0.65).

- o Under the existing fares structure it would be possible to make a robust estimate that the receipts gain from a fares rise will be roughly two-thirds of the overall increase.

- o In January 1981 the surprisingly low elasticity of -0.17 reflects a low level of lost trips despite the high (30%) fares increase. It is likely that the large increase in discount for passes encouraged riders to switch ticket rather than mode. Rail trips in particular were hardly affected.

- o The June 1981 fares revision, though smaller than the earlier (12% overall), had a greater impact, especially on bus trips. Other factors may have influenced bus travel in this period.

- o In 1986 the effect was more even with an overall elasticity of -0.27. However, a higher proportion of rail journeys were lost due to the larger increase for rail and no relief on pass prices.

FIGURE 4

ELASTICITY ESTIMATES

DATE	FARES INCREASE	UNLINKED TRIP LOSS TOTAL	UNLINKED TRIP LOSS BUS	UNLINKED TRIP LOSS RAIL	RECEIPTS GAIN	RECEIPTS/PRICE RATIO	TRIP/PRICE RATIO TOTAL	TRIP/PRICE RATIO BUS	TRIP/PRICE RATIO RAIL
January 1981	30%	-5%	-6%	-1%	19%	0.63	0.17	0.20	0.03
July 1981	12%	-7%	-8%	-2%	8%	0.66	0.59	0.66	0.16
February 1986	18%	-5%	-5%	-5%	11%	0.65	0.27	0.33	0.22
						AVERAGES	0.34	0.40	0.14

Over the whole period on average the implied elasticity for all modes and tickets was -0.34, close to the typical value for developed countries in the West.

- Rail users were less sensitive to price changes than bus users; probably for the usual combined reasons for longer journey length and greater affluence.

Figures 5 and 6, following this page, show time series plots (1980/1, 1985/6) of revenue for CTA services as a whole and for passes only.

4. CENTRAL AREA CORDON COUNTS

Every year in April or May (usually May) there is a Cordon Count of passengers entering and leaving Chicago's City Center as defined by the Chicago Area Transportation Study. These are useful for

- Checking the conclusions reached from analyzing receipts data
- Highlighting differences between radial travel and non CBD travel.

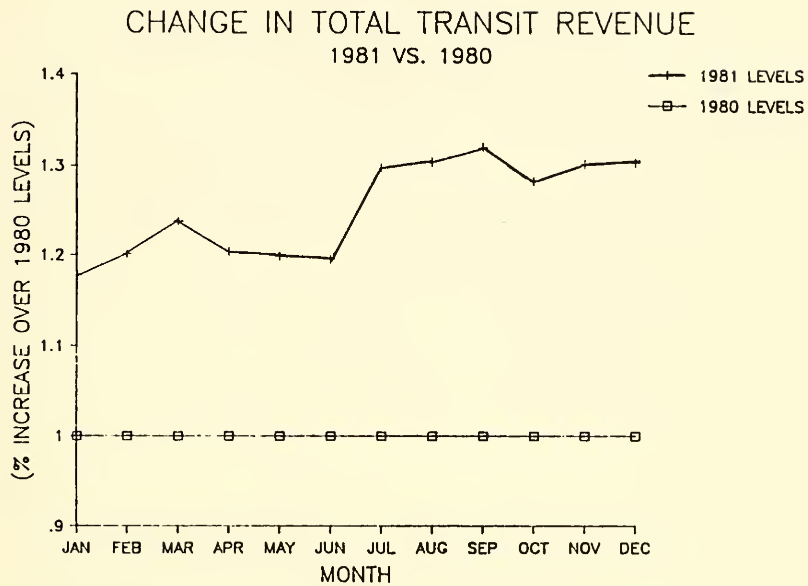
1) Rail

Figure 7 plots the observed rail traffic measured in persons per day averaged by direction. It confirms that:

- In 1981, the net loss of passengers over both fares revisions was quite small (3%).
- In 1986, the observed loss of passengers was higher (7%); this was consistent with the receipts analysis.

In both periods, peak counts dropped less than all day counts indicating higher elasticity for optional off-peak travel.

FIGURE 5


CHANGE IN TOTAL TRANSIT REVENUE
1981 VS. 1980
1981 LEVELS
1980 LEVELS
(% INCREASE OVER 1980 LEVELS)
1.4
1.3
1.2
1.1
1
.9
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

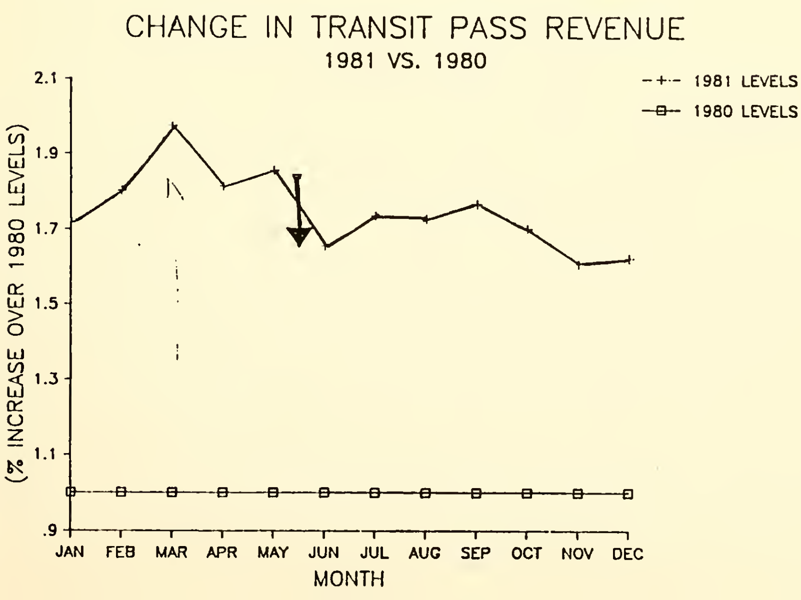
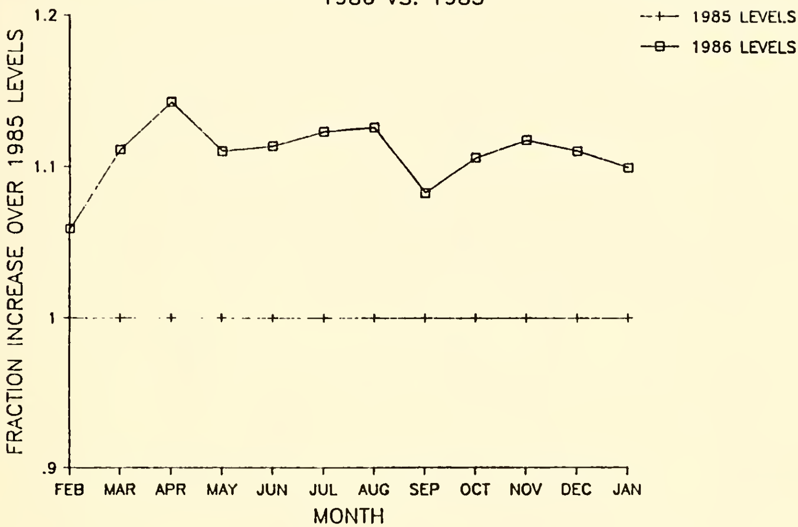

CHANGE IN TRANSIT PASS REVENUE
1981 VS. 1980
1981 LEVELS
1980 LEVELS
(% INCREASE OVER 1980 LEVELS)
2.1
1.9
1.7
1.5
1.3
1.1
.9
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

FIGURE 6

CHANGE IN TOTAL TRANSIT REVENUE
1986 VS. 1985



CHANGE IN TRANSIT PASS REVENUE
1986 VS. 1985

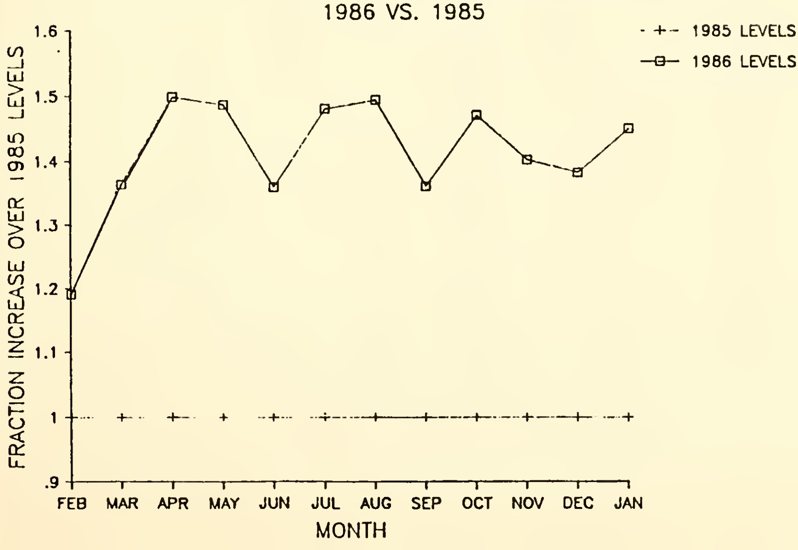
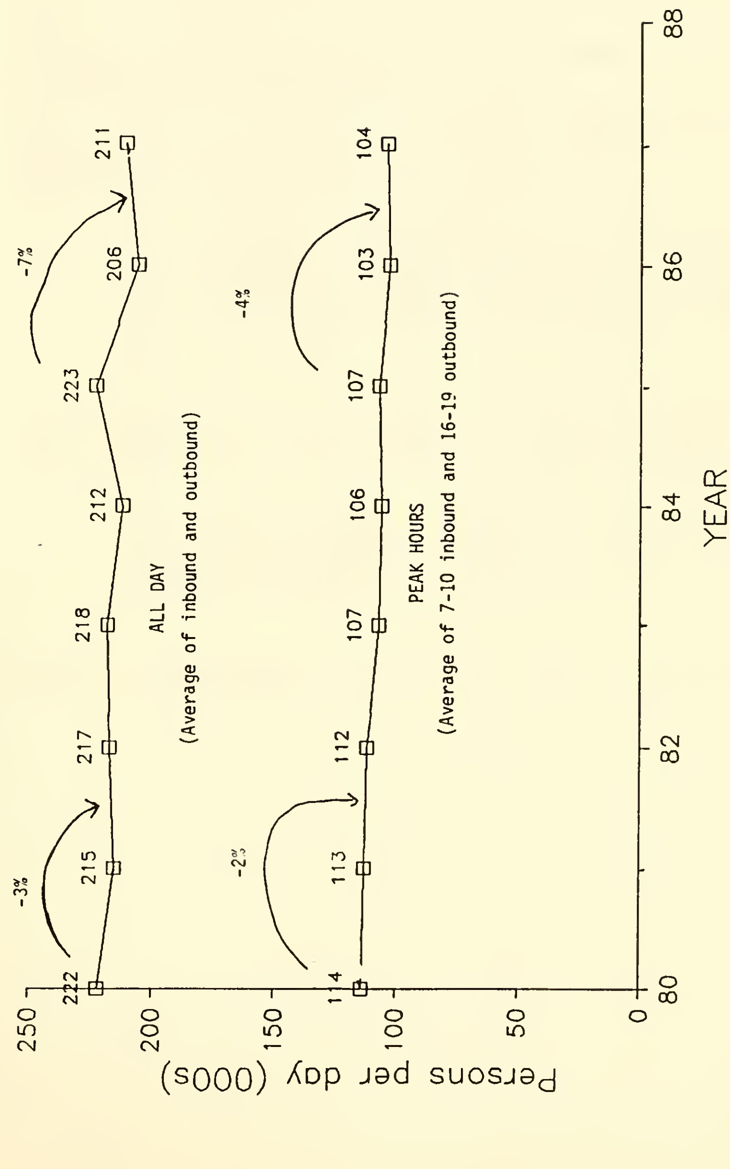


FIGURE 7. ANNUAL CBD CORDON COUNTS

(CTA rail)



2) Bus

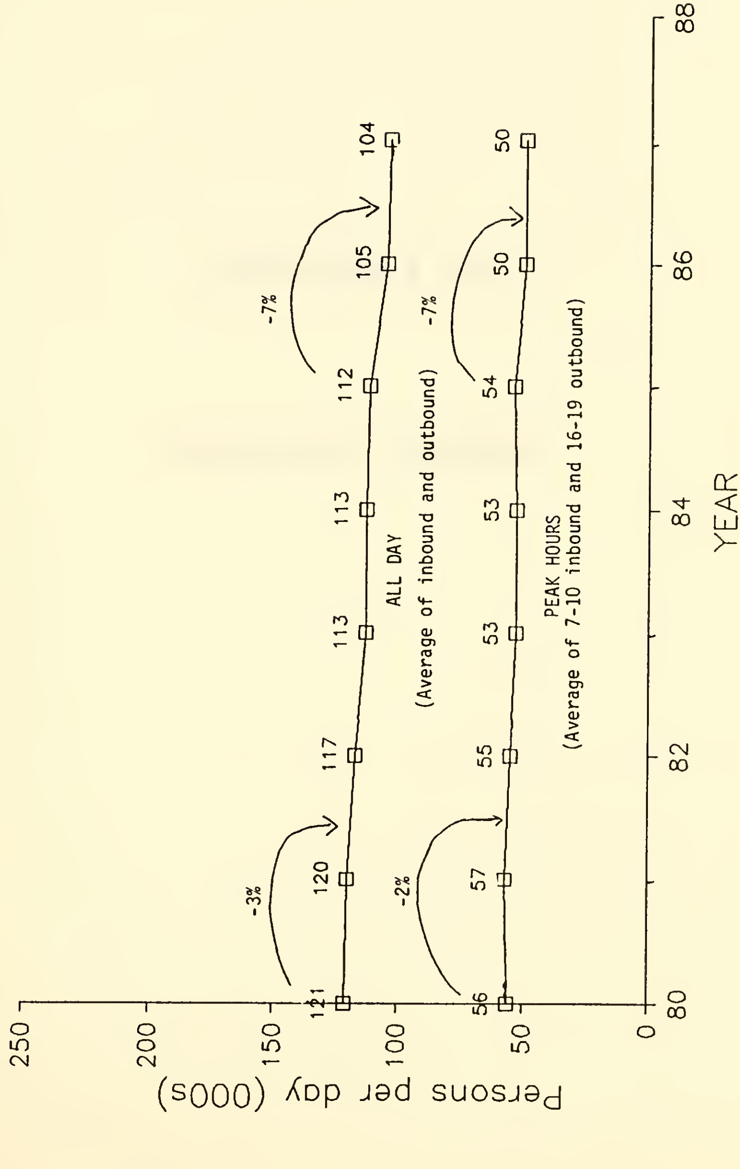
Figure 8, following this page, shows the cordon counts for bus passengers.

- The 1981 bus receipts analysis showed a drop of about 15% in demand over both fares revisions. The CBD counts exhibit an all day drop of 3%.
  - The apparent discrepancy could be explained by the diversity of bus travel patterns with much of the drop in demand occuring in the suburban market. Bus traffic in the CBD responded to the 1981 fares revisions in a similar manner as rail traffic; 2% less in the peaks, 3% all day.
- In 1986, there was a 7% drop throughout the day with no difference in the peaks. This was higher than the overall drop of 5% recorded in unlinked trips.
  - It could be that a high proportion of radial bus trips involve transfers so that this section of passengers had a higher fares increase than single link bus users who had no increase in fare.

In general, the evidence from the CBD counts is consistent with analysis of receipts data.

FIGURE 8. ANNUAL CBD CORDON COUNTS

(CTA bus)



APPENDIX A3

LITERATURE REVIEW

APPENDIX A3

LITERATURE REVIEW

A review of literature was undertaken, covering research into the estimation of fares elasticities, the impact of prepaid tickets and the long term effects of fares policies.

Six English papers were studied, to put the results derived from the survey analysis into an overall perspective of long term effects of changes in fares policies.

The papers reviewed covered:

- Travel trends with particular reference to the effect of ticketing initiatives
- The long term effects of public transportation subsidies and fares policies
- The impact and responses to Travelcards (zonal, prepaid period tickets)

A short synopsis of each paper is provided below.

(1) Traffic trends since 1970. An analysis of London Bus and Underground travel trends (1970-85). Ec Research Report R266, April 1986.

This paper produced refined estimates of sensitivity of traffic on London Regional Transport's services to factors such as fares and ticketing, service level and quality and external social and economic trends. Particular attention was given to post - 1981 ticketing initiatives and the benefits arising from them. Elasticities were estimated, (both price and service related). External factors were retail sales, car ownership, traffic congestion, unemployment, population and tourism.

(2) Bus & Underground Travel in London: An Analysis of the years 1966 - 1976, EC Research Report R235, March 1978.

This paper is similar to #1 above but covers an earlier period. It also provides a breakdown of peak travel trends.

(3) Long term effects of public transport subsidy, Philip Goodwin, University of Oxford, (Transport subsidy, Ed. Glaister, 1987).

This paper concluded that fares and subsidy policies required as much as five years to be properly evaluated. Over this longer period, elasticities may be twice the size of those commonly used in short term analyses. Younger groups were found to be more volatile in their travel habits.

SUMMARY OF FARES ELASTICITIES*

MODE	PEAK		OFF PEAK	
	Short Term	Long Term	Short Term	Long Term
BUS	- 0.25	- 0.40	- 0.35	- 0.5
SUBWAY	- 0.10	- 0.15	- 0.30	- 0.45

* Elasticities conditional on no change in mass transit fares relativities.

(4) Experience with Travelcards elsewhere. Notes for LRT Board seminar. December 9,1985.

This paper reviews the experience of Travelcards outside London. The general conclusions were that they were successful in virtually all cases. References made to improve market penetration, increased user benefits and customer loyalty (cf department store credit cards).

(5) **The Travelcard balance sheet, The effects of Travelcards in London on transport operations and passenger demand. LRT briefing paper. July 7, 1987.**

This paper provides a comprehensive statement of the impact of Travelcards, addressing basic philosophy, revenue and traffic generation, congestion, operating costs and policy implications. "Benefits" were put at UK Sterling 200 million per annum; costs were modest; extra rail investment was self-financing. Evidence suggested similar results for Capitalcards.

(6) **Attitudes, behavior and responses of Travelcard holders in London. An exploratory study. Peter Jones, Oxford Transport Studies Unit, November 1987.**

This paper has two main conclusions:

(i) Travelcards make a greater difference to non-car owners than car owners.

The report shows clearly that it is the non-car owner who makes more diverse public transport trips and obtains the greatest value and satisfaction from a Travelcard. The consultants suspect that the behavioral key may be the decision to take driving lessons - with possession of a Travelcard tending to encourage delay.

(ii) The value of Travelcards involves more than simple cash savings:

- Passengers appreciate the flexibility,even in their journey work
- the general convenience, avoidance of queues and fiddling with cash is also valued
- additional travel in off-peak often involves an accompanying cash payer

SUMMARY OF TRAVELCARD RESULTS

While cash savings may be important, perhaps of primary importance is that Travelcards as a product have significant advantages in their own right which passengers come increasingly to value - particularly the non-car owners whose retention is so vital in the long term.

APPENDIX B

The Disadvantaged and Public Transportation: An Internal Discussion Paper

Erwin A. France and Associates

THE DISADVANTAGED AND PUBLIC TRANSPORTATION:

An Internal Discussion Paper

Erwin A. France and Associates

This Appendix is based upon a study conducted by Erwin A. France and Associates as part of the Fares Structure Analysis Demonstration Study. The contents of this study have been edited by LTI Consultants, Inc. where appropriate in line with the overall framework of the fares analysis work.

This is a background paper on the Disadvantaged and the impacts of certain fare structure options on them. Before proceeding, it is important that a clear understanding of the definition of Disadvantaged is established and how the term will be used in the test. The U.S. Department of Labor defines Disadvantaged as a low income person who:

> "does not have suitable employment and is either: 1) a school dropout; 2) a minority member; 3) under 22 years of age; 4) more than 45 years of age; or 5) disabled."

For the purposes of the analyses in this paper, the term Disadvantaged will refer to low income populations, minorities, and persons 55 years and older.

The main goal of this paper is to evaluate the fare structure options (to be discussed in a later section) as to their effectiveness in serving the Disadvantaged in the Chicago Transit Authority's Service Area (CTASA) on a more equitable basis. Equity itself is considered by public officials as more than just the degree to which inequality exists. Generally, they consider:

1) The significance of the item with which in equality exists;

2) The extent to which the claimants are deserving of public assistance;

3) The degree to which the claimants constitute a well organized block of voters;

4) The risk that a favorable response would antagonize other groups; and

5) The extent to which such a response would initiate massive new expenditures requirements.

The concepts of equity in urban transportation are as follows:

1) Fee for service:
   To each according to his or her financial contribution.

2) Equality in service distribution:
To each an equal share of public expenditure, regardless of need or financial contribution.

3) Distribution according to need:
To each a share of public expenditure or service based on need as government has chosen to define it, preferably with the revenues drawn predominantly from those in least financial need.

The analysis of the fare structure option impacts on the Disadvantaged in the CTASA will concentrate on or maintain in theme issues of equity. That is, it will develop the framework for assessing and implementing a more equitable fare structure for the CTASA.

Subsequent to further analysis of the fare structure option impacts on the Disadvantaged, the reader needs to gain a clear understanding of the Disadvantaged in the CTASA; their general characteristics as well as their public transportation ridership characteristics.

- o First, we will examine the Disadvantaged by age, race, and income and poverty status to attain an overall picture of the distribution of these populations throughout the CTASA.

- o Second, we will direct the analysis on the Chicago Transit Authority (CTA) riders and formulate conclusions as to the impacts of varying fare structures on these populations as low income individuals.

The purpose of identifying the characteristics of all Disadvantaged individuals who live in the CTASA is to perpetuate the formulation of possible new marketing strategies and the execution of new studies to explore methods of gaining higher CTA ridership by the Disadvantaged. The analysis of the impacts of the varying fare structures on CTA's present riders stays within the confines of what we know today. We are looking at present data on CTA ridership to outline the positive and negative impacts of different fare structures on the Disadvantaged. Thus, as a short range goal, we look closely at the current data on CTA ridership and identify the tactics that can be implemented to produce a more equitable

fare structure given the considerations described under the concept of equity. As a long range goal, we look to develop new marketing strategies to appeal to a greater number of the Disadvantaged based on the identification and understanding of their basic characteristics.

Data collected in this study were generated by LTI Consultants, Inc., or CTA, and taken from the 1980 census. The following is a brief synopsis of some of the results of two surveys CTA conducted in August, 1987 on its riders (respondents:n=1131 for pass users, n=1375 for cash users):

1) The mean household income for pass users was $21,300 and $25,800 for cash fare riders. 10% of the pass users and 21.3% of cash fare payers had incomes greater than $40,000.

2) 65% of pass riders and 73% of cash fare riders had 1 or more autos in their household.

3) Among pass users, 40.9% were White, 46.7% were Black, 6.7% were Hispanic, and 5.7% were Asian. Among cash fare riders, 46.5% were White, 43.5% were Black, 6.5% were Hispanic, and 3.5% were Asian.

I - THE CTA SERVICE AREA: THE DISADVANTAGED POPULATION AT LARGE

The diagram in Appendix 1 presents those populations under consideration, the focus being on low income populations in both the minority and elderly communities.

1. LOW INCOME - ELDERLY AND MINORITY POPULATIONS INCLUDED IN ANALYSIS

Table 1 and Map 1 represent the numbers and percentages of persons in the CTASA who are below the 1979 poverty level.

- In Chicago, the distribution of community areas (CA) with more than 20% of its population below the poverty level, was concentrated primarily on the West and South sides of the city.

- For those CA's with 10%-20% of its population below the poverty level, the distribution is spread from the North to the South sides with the heaviest concentrations on the South side.

- Except for CA 44, the remaining CA's have less than 10% of its population below the poverty level and are located on the outerlying areas of the Northwest and Southwest sides of the city.

- In the 32 suburban communities, there are 5 cities that have more than 20% of its total population below the poverty level and another 5 with 10%-20% of its total population below the poverty level.

Household income data on Chicago CA's demonstrate that there is a higher degree of economic integration within each community area, that is individuals from both extremes of the income chart live in the same community area.

- This trend in Chicago is unlike other major metropolitan areas that witness most of their low income persons living in the same communities and in more centrally located areas.

Map 2 shows the distribution of the cities and community areas in the CTASA by household income.

- In Chicago, those communities with more than 40% of its households making less than $10,000 also represent some of the communities that have more than 20% of its population below the poverty level.
    - These areas, as well, are located on the West and South sides of Chicago.

Tables 2 and 3 show the distribution of journey length distribution for the Activity Center Survey and Place of Work Survey. These compare respondents on low income with the average.

- These tables indicate that those on low income have a shorter than average journey to work to the CBD, but slightly longer journey to work to non CBD destinations.

Tables 4 and 5 show the arrival mode for the two surveys comparing respondents on low income with the average.

- Table 4 shows, as expected, a higher proportion of low income riders (90.4%) traveled to work by transit than the average (79.1%).

- Table 5 shows that for non-work journeys, a higher proportion of low income respondents walked (17.9% versus 11.0%) and a slightly lower proportion traveled by car (27.9% versus 33.3%).

Tables 6 and 7 show how car availability for low income respondents compares with the average.

- For the Journey to Work Survey, just under half the respondents with low income came from households with one or more cars available compared with an average of over 90%.

- For non-work journeys, 43.2% of respondents compared with an average of 25.2% came from households with no car available.

Travel diary surveys of pass versus cash-fare riders taken in August 1987 revealed other interesting average ridership characteristics. Of 1,131 respondents that used passes, the mean income was $20,600 while of 1,375 respondents that paid cash the mean income was $25,100.

- These data counter the belief that passes are more frequently used by higher income passenger than lower income passengers. However, bear in mind that the income figures represent averages and not the full range of incomes of all pass users.
  - This simply states that pass users have on average (by $4,500) lower incomes than cash payers and thus passes are used more by lower income persons.
- To strengthen this finding, a more detailed examination of all incomes of pass and cash users would need to be undertaken by calculating the standard deviation from the mean.

2. MINORITIES - BLACKS, HISPANICS, OTHER

Minorities represent approximately 57% of the population of Chicago (1985 data) while they represent only 11.6% in the suburbs.

- In the CTASA, minorities make up 46% or 1,799,520 of the total population of 3,912,944 persons. Map 3 represents the minority population in the CTASA by city and community area.
- For most of the suburbs in CTA's service area, the percentage of minorities per city was less than 20% in 1980 except for Bellwood, Calumet Park, Evanston, Maywood, and Summit with 42.2%, 54.1, 26.9, 81.9, and 37.7 respectively.

Map 4 shows the poverty status of minorities in the CTASA by those below the poverty level.

- o As the map exhibits, the greatest number of minorities with incomes below the poverty level are located on the West and South sides of Chicago.

- o For the Black population Map 5 reveals that of those communities with significant numbers of blacks (including CA's 25,26,28,29,35,42,43,44, 45,49,53,67,68,69,73, and the city of Summit), four CA's (i.e., 25,35,67,68) have as much as 48% of their population below the poverty level.

- o Hispanics maintain a distribution similar to that of Blacks of below-poverty-level population.

  - As Map 6 shows, CA's 22,23,24,30, and 31 have as much as 37% of the Hispanic population below the poverty level.

  - There is a relatively equal distribution of the poor Hispanic population throughout the city with a concentration in the central and more western areas of Chicago.

- o There is a much lower number of Other minorities below the poverty level in the CTASA with a concentration in the central and North areas of Chicago and no significant number in the Suburbs (see Map 7).

Tables 8 and 9 show the distribution of journey distance for the Activity Center Survey and Place of Work Survey. These compare minority riders with the average.

These tables show that, within the limits of the survey data, the journey lengths of minority riders are no different than those of average riders.

Tables 10 and 11 show the arrival mode for both surveys comparing minority riders with the average.

- o Table 10 indicates that the proportion of minority riders traveling to work by car (16.8%) was only marginally lower than the average (20.9%).

- o Table 11 indicates that, in the case of non-work journeys, a higher proportion (44.3%) of minority riders travel by car than average (33.3%).

Tables 12 and 13 show the level of car availability for minority respondents compared with the average, for the two surveys. These tables are consistent with those showing arrival mode.

- o Table 12 indicates that for work journeys, about twice as many as the average of minority riders come from households with no car available (i.e., 18.2% versus 9.2%).

- o Table 13 shows little difference in the proportion of respondents from non-car available households between minority riders and the average (20.5% versus 25.2%).

3. PERSONS 55 AND OLDER

Map 8 exhibits the distribution of persons 55 and older in the CTASA in 1980. Chicago's distribution by community area is relatively equal while in the suburbs only 5 cities (Cicero, Evanston, Oak Lawn, Oak Park, and Skokie).

- o Map 9 shows the distribution of persons 55 and older whom were below the poverty level in the CTASA.

- o In Chicago by community area, of the total persons 55 years and older, 15 CA's had a significant percentage (40% or more) below the poverty level. These areas are 3,26,27,28,29,33, 34,35,36,37,38,40,42,54 and 68.

- o In the cities mentioned above, the numbers of persons and older are in most cases less than 500.

  - Cicero, Oak Park, and Skokie had 13%, 8.4% and 4% respectively, of their total population 55 and older below the poverty level.

Data from the Activity Center surveys reveal interesting characteristics of persons 45 and older. (Consistent processed data was unavailable, thus cross tabulations between census data and surveys are slight overestimates.)

- o 25.7% of persons 45 and older had incomes less than $10,000.

- o It was also revealed that individuals 45 to 64 made both long CBD and non-CBD journeys while those 65 and older made shorter CBD and non-CBD journeys.

- o For CTA riders 45 and older the results of journey distance were rather mixed.

  - There were no set travel patterns for this group of transit riders between short, medium, or long CBD and non-CBD journeys. However, for those respondents ages 45 to 64 more short and long CBD and non-CBD trips than medium.

  - Those 64 and older made more short CBD trips and more long non-CBD.

II - IMPACTS OF FARE STRUCTURE OPTIONS ON THE DISADVANTAGED

1. PEAK/OFF PEAK FARES

(1) Low Income

A reduced off-peak fare would benefit those on low income without work since they would not need to travel during peak hours.

- The non-work survey data did not reveal, however, a higher proportion of low-income respondents using transit, but did indicate a higher proportion walking.

(2) Minority

The surveys suggested that a slightly larger than average proportion of minorities used transit for the journey to work but a slightly lower than average for non-work journeys.

- This would imply that minority riders would disbenefit from a peak/off-peak fare structure compared to the average.
  - However, the differences in proportions are probably too small to enable reliable conclusions to be reached.

(3) Equity Concerns of Discounted Off Peak Fares

This type of off-peak fare pricing by discounting off peak travel is an equitable method of charging.

- The costs of providing peak hour transportation are generally greater than the corresponding costs of off peak hour transportation despite the higher rush hour load factors.

- Because the CTA operates under a flat fare system, the fares for peak hour travel cover a much smaller percentage of the operating costs than do off peak travel.

- Thus, transit riders traveling during the peak periods are, in effect, more subsidized than those traveling during the off peak periods.

o Given the above, and that the Disadvantaged account for a higher percentage of off peak ridership, an off peak discounted fare structure would, on a more equitable basis, have a positive effect on them as well as satisfy the concepts of equity (includes low income persons 55 and older).

2.. DISTANCE BASED FARE STRUCTURES

(1) Low Income - Includes Low Income Persons 55 and Older

Diagram 1A and 1B represent two zone structures for transit fares as each relates to the low income populations in the CTASA.

o In diagram 1A, the zone structure holds approximately 8.1% of the total population below the poverty level inside the boundaries of the CBD (zone 1).

o Zone 2 holds 47.3% of the total population below the poverty level while 44.6% are in the outer zone, zone 3.

o In diagram 1B, zone 2 holds approximately 76.1% of the total population below the poverty level and the outer zone contains only 15.8%.

As discussed earlier, the survey results suggest that the low income population travel further than average to work, but make shorter than average non-work journeys.

- A distance-based fare structure would therefore affect low income workers adversely but benefit those making non-work journeys.

    - This pattern is different form that found in many other cities which often have poorer communities concentrated in the inner areas involving shorter than average journeys to the central area.

Given that there is usually little discretion about making work journeys, a distance-based option in the CTA service area would affect adversely those on low-incomes more than the average.

The effectiveness of a London based zonal fare structure promoting equity in the CTASA depends on where the boundaries of each zone are drawn.

- Immediately one can realize that the zone structure in diagram 1B presents a more favorable fare structure in the interests of poorer individuals.

    - A higher percentage of their population would be located in zone 2 and given their travel patterns as being long for both CBD and non-CBD journeys, a greater number of areas and destinations are more accessible at a lower fare.

- As a result of a high degree of economic integration in Chicago's community areas, it is difficult to siphon out higher income individuals to ease the transportation disparities of poorer populations without jeopardizing the concept of equity.

We can make a few other conclusions as to the appropriateness of a zonal fare structure and how it compares to the present flat fare structure the CTASA now operates in.

- The need for transfers is significantly reduced.

- As the system stands now, an individual who, for example, lives on the South side and works on the North side can board, for example, the Jeffery Express at 103rd and Torrence and ride it to Wacker and Wabash in the Loop. Then, board the Wilson/ LaSalle Express bus and ride it to Ravenswood on the North side and pay only $1.25 with a transfer.

o Implementing a London based zonal fare would cause anyone taking this route or one similar in distance to pay a higher fare based on having traversed four zones.

  - However, an individual who lives at Indiana and 35th Street and works at Cook County courthouses, this type of fare structure advantageous for traveling to work.

o This person could board the number 35 bus, ride it to California then board the S. California bus and ride it to the courthouses for $1.25 as the structure stands now.

  - Implementing a London based zonal fare structure in this case would reduce the fare for this person because there was travel in only one zone.

o Given the present distributions of low income individuals in the CTASA, there are possible negative impacts of London-type zonal fare structures.

  - For example, comparing Table 14 that presents travel data from 6 CA's, 25,30,43, 49,67 and 77 that travel to CA 28 (in zone 1) for work purposes with the two zone structures, one can achieve an understanding of the potential impacts of this type of structure.

(2) Minorities

The analysis of the low income population in the previous section reveals similar impacts of a zonal fare structure on the minority (and low income minority) populations.

- o Like the low income populations, minorities travel longer distances to work. Diagram 2A and 2B present the distribution in each zone for the minority population below the poverty level.

  - As shown in diagram 2A, 6.9% of the total population of minorities below the poverty level are located inside the CBD (zone 1) while 35.2% are in zone 2 and 56.1% are in outer zone 3. 2B is a second zone structure that holds over 74% of the total minority population below the poverty level in zone 2 and only 20.7% located in outer zone 3.

Referring to Map 14, one finds that twenty CA's have more than 20% of the minority population below the poverty level. Of these CA's, four (i.e., 25,54,67,68) have more than 40% below the poverty level.

- o Incorporating the zone structure in diagram 2A would cause those individuals who live in the aforementioned four community areas to traverse one possibly two zones and pay a higher fare to arrive at their place of work.

- o The zone structure in diagram 2B would be a much more suitable situation whereby at most only 1 zone would be traversed and a lower fare paid to do so.

The conclusion is that a distance-based fare structure would adversely affect poverty-level minority riders more than average in terms of their journey to work.

- o However, of those presented, the zone option presented in diagram 2B has the least detrimental effects in terms of cost to use CTA.

  - A large segment of the minority population falls inside zone 2 and has a wider range of destinations accessible to them at a lower fare than if the zone option in diagram 2A were chosen.

- o However, to achieve a better understanding of the effects of different zone fare structure options, data on travel patterns of the minority rider need to be collected and analyzed beyond the extent of trip distance as outlined earlier.

3. RAIL VERSUS BUS PRICING

On the National level a cross tabulation of computer tapes of the Nationwide Personal Transportation Study, the U.S. Department of Transportation and the Federal Highway Administration, revealed interesting findings on modal usage by household income (see Table 17).

- o The table exhibits percentages of a sample of 11,547 households containing 32,776 persons from metropolitan areas (SMSA's).

  - As shown, transit riders in 1977-78 had much lower incomes, on average, than did auto users and in general had lower incomes than the population as a whole.

  - The under $10,000 group comprised 41.2% of total transit ridership with 47.5% riding bus who had the lowest incomes of any mode's users.

  - By contrast, 33.4% were subway riders and 15.3% rode commuter rail.

- o A fare structure that charges higher fares for any journeys involving rail and not bus would benefit low income persons because as Table 17 demonstrated, they account for a greater percentage of bus ridership.

4. MAXIMUM PREPAYMENT

There is no evidence to suggest that the extension of the range of prepayment instruments would affect minority ridership any differently from the average and no reason to suggest this could be the case.

- In terms of low income groups, the travel diary survey data indicates that pass purchase is distributed across all income groups.

- This suggests that there is no particular income group, high or low, which benefits more than average from pass purchase.

- A key issue would be an adequate distribution system of prepaid tickets to ensure a high level of availability for all income groups.

5. CONCLUSION

This has been a brief synopsis of the Disadvantaged and public transportation shedding light of certain fare structure options and their implications.

- The fare structure options presented in this text identified some of the impacts on the Disadvantaged.

- However, the discussions presented give insight on the current situation in the CTASA and outline the potential impacts of any future fare structure changes.

The pattern of the distribution of low income and minority populations in Chicago is different from most other large cities. Rather than being concentrated in the inner city within easy reach of the Central Business District, in Chicago these populations tend to be concentrated in areas extending both south and west over a considerable distance from the Loop.

- This suggests that rather than benefitting from the introduction of a distance-based fare, disadvantaged groups would probably not be affected any differently than the average.

The data collected as part of the stated preference surveys do suggest that the disadvantaged travel further to

ork than average but make shorter non-work journeys.

- However, the sample sizes of these surveys were not intended for this type of analysis and therefore are probably not sufficiently reliable to enable firm conclusions to be reached.

In the case of the peak/off-peak fare structure, the survey data suggests that minorities would be adversely affected by this option but again the comments made above (compared with the average) regarding reliability of the data also apply.

Table 1
Individuals Below Poverty Line
By Community in CTA's Service Area

COMMUNITY AREA	POPULATION	# BELOW THE '79 POVERTY LEVEL	PERCENTAGE OF TOTAL POPULATION
1. Rogers Park	55,525	8,363	15.0
2. West Ridge	61,129	3,463	6.0
3. Uptown	64,414	17,614	27.0
4. Lincoln Square	43,954	4,225	9.6
5. North Center	35,161	4,266	12.4
6. Lakview	97,519	12,637	13.0
7. Lincoln Park	57,146	27,523	48.0
8. Near North Side	67,167	28,843	43.0
9. Edison Park	12,547	248	7.6
10. Norwood Park	40,585	1,387	3.4
11. Jefferson Park	24,583	900	3.7
12. Forest Glen	18,991	440	2.3
13. North Park	15,273	869	5.7
14. Albany Park	46,075	5,830	12.7
15. Portage Park	57,349	2,785	4.9
16. Irving Park	49,489	4,352	8.8
17. Dunning	37,860	1,480	4.0
18. Montclare	10,793	593	5.5
19. Belmont Cragen	53,373	3,175	6.0
20. Hermosa	19,547	2,280	11.7
21. Avondale	33,527	3,919	11.7
22. Logan Square	84,768	17,531	21.0
23. Humboldt Park	70,879	19,919	28.0
24. West Town	96,428	29,866	31.0
25. Austin	138,026	32,736	23.7
26. West Garfield Park	38,865	13,256	39.0
27. East Garfield Park	31,580	13,523	43.0
28. Near West Side	57,305	29,299	51.0
29. North Lawndale	61,534	26,165	43.0
30. South Lawndale	75,204	15,212	20.0
31. Lower West Side	44,951	11,814	26.0
32. Loop	6,642	1,198	19.0
33. Near South Side	7,243	3,135	43.0
34. Armour Square	12,475	3,404	27.0
35. Douglas	35,700	14,618	41.0

Table 1 (Continued)
Individuals Below Poverty Line
By Community in CTA's Service Area

COMMUNITY AREA	POPULATION	# BELOW THE '79 POVERTY LEVEL	PERCENTAGE OF TOTAL POPULATION
36. Oakland	16,748	10,933	65.0
37. Fuller Park	5,832	2,475	42.0
38. Grand Blvd.	53,741	29,880	56.0
39. Kenwood	21,974	5,646	26.0
40. Washington Park	31,935	15,670	49.0
41. Hyde Park	31,198	4,700	15.0
42. Woodlawn	36,323	13,743	38.0
43. South Shore	77,743	17,981	23.0
44. Chatham	40,725	5,781	14.0
45. Avalon Park	13,792	1,494	11.0
46. South Chicago	46,422	7,886	17.0
47. Burnside	3,942	725	18.0
48. Calumet Heights	20,505	1,383	7.0
49. Roseland	64,372	11,329	18.0
50. Pullman	19,341	1,484	14.0
51. South Deering	19,400	2,591	13.0
52. East Side	21,311	1,353	6.0
53. West Pullman	44,904	6,794	15.0
54. Riverdale	13,539	6,388	47.0
55. Hegewisch	11,572	600	5.0
56. Garfield Ridge	37,935	2,707	7.0
57. Archer Heights	9,708	501	5.0
58. Brighton Park	30,770	3,148	10.0
59. McKinley Park	13,248	1,536	12.0
60. Bridgeport	30,923	4,856	16.0
61. New City	55,860	13,867	25.0
62. West Elsdon	12,797	605	5.0
63. Gage Park	24,445	1,841	8.0
64. Clearing	22,584	1,031	5.0
65. West Lawn	24,748	953	4.0
66. Chicago Lawn	45,568	4,869	11.0
67. West Englewood	62,069	19,671	32.0
68. Englewood	59,075	23,268	39.0
69. Greater Grand Cr	45,218	11,670	26.0

Table 1 (Continued)
Individuals Below Poverty Line
By Community in CTA's Service Area

COMMUNITY AREA	POPULATION	# BELOW THE '79 POVERTY LEVEL	PERCENTAGE OF TOTAL POPULATION
70. Ashburn	40,477	985	2.0
71. Auburn Gresham	65,132	8,992	14.0
72. Beverly	23,360	781	3.0
73. Washington Hgts.	36,453	4,169	11.0
74. Mount Greenwood	20,084	751	3.0
75. Morgan Park	29,315	3,193	11.0
76. O'Hare	11,068	411	4.0
77. Edgewater	58,561	8,642	15.0
78. Alsip	17,134	1,131	3.8
79. Bellwood	19,811	866	4.4
80. Berwyn	46,849	522	1.1
81. Blue Island	21,855	2,062	9.5
82. Burbank	28,462	1,133	4.0
83. Burnham	4,030	64	1.7
84. Calumet Park	8,788	2,362	6.0
85. Cicero	61,232	5,427	8.9
86. Elmwood Park	24,016	911	3.8
87. Evanston	73,706	4,667	7.1
88. Evergreen Park	22,260	805	3.7
89. Forest Park	15,177	1,015	6.8
90. Harwood Hts.	8,228	392	4.8
91. Hillside	8,279	361	4.4
92. Hometown	5,324	157	3.0
93. Lincolnwood	11,921	219	1.8
94. Maywood	27,998	3,757	13.5
95. Morton Grove	23,747	433	1.8
96. Niles	30,363	915	3.2
97. Norridge	6,764	252	3.7
98. Oak Lawn	60,590	1,972	3.2
99. Oak Park	54,887	2,766	5.1
100. Park Ridge	38,704	720	1.9
101. Riverdale	13,233	551	4.2
102. River Grove	10,368	427	3.8
103. Rosemont	4,137	311	7.6
104. Schiller Park	11,458	672	5.9

Table 1 (Continued)
Individuals Below Poverty Line
By Community in CTA's Service Area

COMMUNITY AREA	POPULATION	# BELOW THE '79 POVERTY LEVEL	PERCENTAGE OF TOTAL POPULATION
105. Skokie	60,278	1,508	3.5
106. Stickney	5,893	403	6.9
107. Summit	10,110	1,032	12.9
108. Westchester	17,730	296	1.7
109. Wilmette	28,229	775	2.8

Cross tabulations adapted for the Local Community Fact Book of Chicago Metropolitan Area, University of Illinois at Chicago, 1980

TABLE 2

	01	02	03	04	05	06	07	08	09
	26,245	24,962	28,259	18,753	14,067	52,167	31,781	36,488	4,715
LESS THAN $2,500	1,454	727	3,058	732	697	2,775	1,659	2,163	72
$2,500 TO $4,999	2,851	1,409	4,756	1,528	1,408	4,666	2,405	4,047	173
$5,000 TO $7,499	2,272	1,588	2,916	1,606	1,353	4,176	1,903	2,336	214
$7,500 TO $9,999	2,344	1,731	2,552	1,649	1,096	3,912	1,838	2,004	303
$10,000 TO $12,499	2,910	1,852	2,737	1,894	1,281	4,915	2,581	2,384	288
$12,500 TO $14,999	2,300	1,590	1,822	1,508	902	4,113	2,300	1,974	287
$15,000 TO $17,499	2,452	1,783	2,017	1,499	1,086	4,286	2,738	2,636	251
$17,500 TO $19,999	1,754	1,429	1,567	1,407	1,068	3,598	1,874	1,589	294
$20,000 TO $22,499	1,697	1,925	1,388	1,278	1,030	3,857	2,399	2,278	347
$22,500 TO $24,999	1,102	1,387	988	1,091	831	2,269	1,478	1,252	357
$25,000 TO $27,499	1,165	1,435	998	852	697	2,245	1,496	1,524	296
$27,500 TO $29,999	684	1,193	652	756	495	1,522	1,072	997	244
$30,000 TO $34,999	1,255	2,075	782	1,073	841	2,618	2,170	1,790	521
$35,000 TO $39,999	777	1,542	568	651	432	1,866	1,294	1,325	359
$40,000 TO $49,999	597	1,617	714	666	535	2,275	1,636	2,166	362
$50,000 TO $74,999	506	1,224	521	448	284	1,984	1,852	2,579	256
$75,000 OR MORE	125	455	223	115	31	1,090	1,086	3,444	91

	10	11	12	13	14	15	16	17	18
	14,995	9,914	6,803	5,399	16,272	22,740	20,489	13,879	4,103
LESS THAN $2,500	225	196	121	120	792	490	839	244	153
$2,500 TO $4,999	722	551	243	192	1,279	1,645	1,772	817	249
$5,000 TO $7,499	756	684	213	307	1,356	1,487	1,539	985	299
$7,500 TO $9,999	815	649	263	316	1,230	1,683	1,665	870	216
$10,000 TO $12,499	1,017	687	331	434	1,420	1,934	1,714	862	340
$12,500 TO $14,999	675	682	205	342	1,215	1,693	1,587	944	285
$15,000 TO $17,499	1,020	686	341	413	1,387	1,714	1,742	893	285
$17,500 TO $19,999	695	532	362	302	1,057	1,488	1,467	889	256
$20,000 TO $22,499	1,077	785	415	375	1,174	1,671	1,491	1,110	264
$22,500 TO $24,999	987	632	351	350	881	1,302	1,120	829	281
$25,000 TO $27,499	958	669	446	286	779	1,442	1,139	816	253
$27,500 TO $29,999	965	541	391	294	664	1,154	831	714	251
$30,000 TO $34,999	1,499	787	677	455	1,035	1,687	1,387	1,380	362
$35,000 TO $39,999	1,143	587	570	320	720	1,204	908	969	225
$40,000 TO $49,999	1,476	746	712	457	776	1,355	750	889	274
$50,000 TO $74,999	817	417	782	285	401	701	431	600	68
$75,000 OR MORE	148	61	380	151	106	110	107	70	44

	19	20	21	22	23	24	25	26	27
	21,194	7,089	13,160	29,317	21,230	32,233	41,350	9,257	9,895
LESS THAN $2,500	605	297	630	1,906	2,000	3,646	3,975	1,267	1,544
$2,500 TO $4,999	1,713	773	1,274	3,842	3,112	5,085	4,446	1,604	2,034
$5,000 TO $7,499	1,743	492	1,052	2,767	1,817	3,091	3,195	982	1,193
$7,500 TO $9,999	1,478	566	1,300	2,679	1,838	3,128	3,212	900	922
$10,000 TO $12,499	1,702	554	1,217	3,012	2,078	3,005	3,624	667	857
$12,500 TO $14,999	1,386	492	994	2,087	1,344	2,344	2,784	550	573
$15,000 TO $17,499	1,501	656	924	1,972	1,463	2,406	2,838	587	590
$17,500 TO $19,999	1,549	614	972	1,985	1,296	1,938	2,512	405	474
$20,000 TO $22,499	1,604	443	941	1,905	1,212	1,951	2,593	528	326
$22,500 TO $24,999	1,280	373	767	1,432	795	1,080	1,979	322	269
$25,000 TO $27,499	1,410	390	857	1,290	847	1,069	2,042	318	282
$27,500 TO $29,999	880	314	382	1,040	633	715	1,418	258	226
$30,000 TO $34,999	1,668	385	722	1,386	1,037	1,122	2,543	336	237
$35,000 TO $39,999	941	342	520	859	552	584	1,656	177	164
$40,000 TO $49,999	1,127	253	397	710	467	644	1,557	209	127
$50,000 TO $74,999	535	112	194	317	301	288	785	91	55
$75,000 OR MORE	72	33	17	128	38	117	191	56	22

	28	29	30	31	32	33	34	35	36
	18,630	17,266	19,197	13,036	3,853	2,419	4,505	14,319	4,894
LESS THAN $2,500	3,190	2,115	1,392	1,370	346	241	484	1,935	971
$2,500 TO $4,999	5,189	3,692	1,951	1,454	584	822	977	3,230	1,685
$5,000 TO $7,499	2,169	1,975	1,693	1,277	533	338	424	1,389	575
$7,500 TO $9,999	1,499	1,647	1,624	1,138	299	185	327	1,291	450
$10,000 TO $12,499	1,230	1,494	1,691	1,313	249	154	370	968	456
$12,500 TO $14,999	924	1,118	1,324	992	201	195	189	810	172
$15,000 TO $17,499	850	1,161	1,878	1,170	109	134	273	763	110
$17,500 TO $19,999	682	720	1,346	799	181	51	217	894	101
$20,000 TO $22,499	567	693	1,358	745	173	63	241	704	79
$22,500 TO $24,999	404	658	996	461	147	80	239	425	63
$25,000 TO $27,499	382	472	1,051	521	143	31	134	389	76
$27,500 TO $29,999	313	384	549	398	98	35	150	312	9
$30,000 TO $34,999	355	546	893	560	174	59	188	403	64
$35,000 TO $39,999	342	307	609	285	130	20	106	206	25
$40,000 TO $49,999	255	287	501	265	133	11	86	275	46
$50,000 TO $74,999	196	197	253	253	270	0	80	237	19
$75,000 OR MORE	83	0	88	33	89	0	20	88	13

	37	38	39	40	41	42	43	44	45
	1,930	18,601	10,006	11,028	14,545	14,138	31,393	16,361	4,276
LESS THAN $2,500	246	3,534	1,159	1,906	926	2,313	2,562	1,023	201
$2,500 TO $4,999	424	5,337	1,314	2,511	1,469	3,257	3,804	1,486	229
$5,000 TO $7,499	268	2,527	1,060	1,724	1,254	1,485	2,505	1,178	199
$7,500 TO $9,999	258	1,827	702	1,074	1,259	1,341	2,567	1,390	271
$10,000 TO $12,499	146	1,364	847	930	1,257	1,180	3,297	1,594	276
$12,500 TO $14,999	88	903	571	569	1,043	870	2,098	1,220	189
$15,000 TO $17,499	109	692	640	428	1,084	825	2,404	1,185	362
$17,500 TO $19,999	86	609	605	357	851	530	2,232	1,095	276
$20,000 TO $22,499	54	499	598	352	946	550	1,924	1,092	265
$22,500 TO $24,999	34	297	371	291	584	411	1,603	954	235
$25,000 TO $27,499	49	190	359	194	541	374	1,161	701	226
$27,500 TO $29,999	54	126	245	176	337	196	967	590	166
$30,000 TO $34,999	48	286	391	214	659	318	1,461	998	432
$35,000 TO $39,999	13	173	306	119	481	195	1,009	651	259
$40,000 TO $49,999	32	146	261	120	745	167	1,006	682	447
$50,000 TO $74,999	19	69	301	44	790	75	623	441	204
$75,000 OR MORE	0	22	256	19	319	51	170	81	39

	46	47	48	49	50	51	52	53	54
	14,379	1,015	6,167	18,058	3,384	5,669	7,436	11,732	3,393
LESS THAN $2,500	905	12	208	999	158	297	207	591	384
$2,500 TO $4,999	1,508	94	208	1,362	306	472	495	780	693
$5,000 TO $7,499	899	35	232	1,219	185	308	447	650	413
$7,500 TO $9,999	809	92	288	1,140	259	242	552	616	307
$10,000 TO $12,499	1,048	64	289	1,392	244	459	439	842	260
$12,500 TO $14,999	911	88	353	1,151	142	285	351	733	224
$15,000 TO $17,499	1,135	70	384	1,239	225	407	345	817	189
$17,500 TO $19,999	941	54	336	1,267	300	416	420	803	149
$20,000 TO $22,499	1,217	114	397	1,188	233	448	702	969	181
$22,500 TO $24,999	891	44	424	1,031	215	407	511	747	139
$25,000 TO $27,499	689	58	406	1,002	150	317	418	778	85
$27,500 TO $29,999	693	108	342	714	189	239	377	629	137
$30,000 TO $34,999	1,000	82	600	1,331	302	502	790	1,142	99
$35,000 TO $39,999	661	46	576	1,108	237	327	445	701	42
$40,000 TO $49,999	642	48	584	1,155	105	288	503	556	55
$50,000 TO $74,999	331	0	449	657	107	216	398	302	31
$75,000 OR MORE	99	6	91	103	27	39	36	76	5

	55	56	57	58	59	60	61	62	63
	6,157	12,624	3,689	12,214	4,810	11,377	17,100	4,833	9,340
LESS THAN $2,500	181	324	100	562	224	730	1,403	126	332
$2,500 TO $4,999	252	717	223	1,181	496	1,248	2,223	304	871
$5,000 TO $7,499	248	674	199	1,060	456	879	1,628	283	734
$7,500 TO $9,999	271	753	245	1,023	399	1,097	1,627	319	681
$10,000 TO $12,499	262	738	340	1,158	373	1,116	1,524	358	708
$12,500 TO $14,999	174	654	225	851	310	725	1,155	315	572
$15,000 TO $17,499	214	772	238	828	328	782	1,237	334	603
$17,500 TO $19,999	211	793	313	792	283	660	1,140	324	675
$20,000 TO $22,499	358	1,008	228	920	328	789	1,051	386	696
$22,500 TO $24,999	272	843	213	653	239	529	760	227	621
$25,000 TO $27,499	311	904	235	711	286	582	715	390	598
$27,500 TO $29,999	264	663	154	398	249	435	508	215	420
$30,000 TO $34,999	434	1,210	322	705	292	666	893	422	763
$35,000 TO $39,999	241	950	185	509	155	351	451	351	365
$40,000 TO $49,999	302	916	288	468	210	476	499	274	431
$50,000 TO $74,999	136	639	163	349	157	261	253	191	240
$75,000 OR MORE	26	66	18	46	25	51	33	14	30

	64	65	66	67	68	69	70	71	72
	8,067	8,989	17,600	16,086	17,787	16,968	12,817	19,260	7,602
LESS THAN $2,500	218	232	783	1,466	2,301	1,628	199	1,024	120
$2,500 TO $4,999	373	512	1,528	2,071	3,641	2,537	464	1,328	288
$5,000 TO $7,499	388	462	1,656	1,443	1,885	1,640	354	1,173	311
$7,500 TO $9,999	394	555	1,295	1,391	1,602	1,437	523	1,260	397
$10,000 TO $12,499	432	582	1,256	1,317	1,615	1,624	609	1,608	326
$12,500 TO $14,999	500	473	1,223	1,187	1,345	996	472	1,382	397
$15,000 TO $17,499	574	662	1,264	1,134	928	1,227	723	1,231	442
$17,500 TO $19,999	564	505	1,259	1,133	793	1,070	704	1,426	383
$20,000 TO $22,499	736	590	1,503	1,101	893	1,017	1,113	1,331	610
$22,500 TO $24,999	585	535	924	772	746	774	1,008	1,106	368
$25,000 TO $27,499	607	705	956	645	497	784	1,013	953	479
$27,500 TO $29,999	459	587	781	469	359	369	759	981	344
$30,000 TO $34,999	911	751	1,038	777	465	714	1,496	1,490	842
$35,000 TO $39,999	484	572	792	531	274	429	1,115	1,083	570
$40,000 TO $49,999	455	720	786	381	270	361	1,227	1,090	657
$50,000 TO $74,999	329	491	420	218	143	310	893	710	776
$75,000 OR MORE	58	55	136	50	30	51	145	84	292

	73	74	75	76	77
	10,114	6,684	8,792	5,467	29,249
LESS THAN $2,500	399	123	366	121	1,935
$2,500 TO $4,999	492	296	581	148	3,320
$5,000 TO $7,499	476	404	451	176	2,657
$7,500 TO $9,999	424	393	465	300	2,773
$10,000 TO $12,499	602	421	583	369	2,826
$12,500 TO $14,999	746	415	548	383	2,106
$15,000 TO $17,499	762	448	610	506	2,040
$17,500 TO $19,999	668	394	469	436	1,750
$20,000 TO $22,499	712	561	657	643	1,712
$22,500 TO $24,999	496	462	479	385	1,208
$25,000 TO $27,499	680	453	575	303	1,142
$27,500 TO $29,999	564	367	436	298	764
$30,000 TO $34,999	980	599	782	562	1,404
$35,000 TO $39,999	734	466	557	306	1,144
$40,000 TO $49,999	842	526	469	320	1,058
$50,000 TO $74,999	504	301	431	163	1,004
$75,000 OR MORE	33	55	133	48	406

TABLE 3

MARKET SEGMENT BY INCOME-ACTIVITY CENTER SURVEY

	Income < $10,000 Number	Percent
Short CBD	6	3.4
Med. CBD	13	8.5
Lond CBD	20	13.1
Short non-CBD	35	22.9
Med. non-CBD	49	32.0
Long non-CBD	30	19.6
Total	153	100.0

TABLE 4

MARKET SEGMENT BY INCOME-PLACE OF WORK SURVEY

	Income < $10,000	
	Number	Percent
Short CBD	4	7.4
Med. CBD	14	25.0
Lond CBD	13	24.1
Short non-CBD	3	5.6
Med. non-CBD	8	14.8
Long non-CBD	12	22.2
Total	54	100.0

Tables 3-14 adapted from surveys conducted in August 1987 and processed by Chicago Transit Authority and LTI Consultants, Inc.

TABLE 5

ARRIVAL MODE BY INCOME-ACTIVITY CENTER SURVEY

Income < $10,000

Arrival mode	number	percent
Car	45	27.8
Transit	88	54.3
Walk	29	17.9
Total	162	100.0

TABLE 6

ARRIVAL MODE BY INCOME-PLACE OF WORK SURVEY

Income < $10,000

Car/transit mode	Number	Percent
Car throughout	5	9.6
Transit all or part	47	90.4
Total	52	100.0

TABLE 7

VEHICLES OWNED BY INCOME - ACTIVITY CENTER SURVEY

Income < $10,000

	Number	Percent
Cars owned by Household		
0	70	43.2
1	59	36.4
2	21	13.0
3	9	5.6
4	2	1.2
5	1	.6
*Total	162	100.0

TABLE 8

VEHICLES OWNED BY INCOME - PLACE OF WORK SURVEY

Income < $10,000

	Number	Percent
Cars owned by Household		
0	27	50.9
1	14	26.4
2	7	13.2
3	4	7.5
4	1	1.9
Total	58	100.0

TABLE 9

MARKET SEGMENT BY RACE - ACTIVITY CENTER SURVEY

	Minority	
	Number	Percent
Short CBD	6	1.4
Med CBD	41	9.9
Long CBD	47	11.2
Short non-CBD	70	16.8
Med non-CBD	147	35.3
Long non-CBD	105	25.2
Total	416	100.0

TABLE 10

ARRIVAL MODE BY RACE-ACTIVITY CENTER SURVEY

	Minority	
Arrival Mode	Number	Percent
Car	210	44.3
Transit	229	48.3
Walk	35	7.4
Total	474	100.0

TABLE 11

VEHICLES OWNED BY INCOME - ACTIVITY CENTER SURVEY

Income < $10,000

Vehicles owned by Household	Number	Percent
0	97	20.5
1	177	37.3
2	131	27.6
3	45	9.5
4	15	3.2
5	6	1.3
7	2	.4
9	1	.2
Total	474	100.0

TABLE 12

MARKET SEGMENT BY RACE - PLACE OF WORK SURVEY

Minority

	Number	Percent
Short CBD	9	2.0
Med. CBD	81	18.3
Lond CBD	221	50.0
Short non-CBD	18	4.1
Med. non-CBD	39	8.8
Long non-CBD	74	16.7
Total	442	100.0

TABLE 13

ARRIVAL MODE BY RACE - PLACE OF WORK SURVEY

	Minority	
	Number	Percent
Car/transit mode		
Car throughout	74	16.8
Transit all or part	366	83.2
Total	439	100.0

TABLE 14

VEHICLES OWNED BY RACE - PLACE OF WORK SURVEY

	Minority	
	Number	Percent
Cars owned by Household		
0	80	18.2
1	183	41.7
2	123	28.0
3	41	9.3
4	11	2.5
7	1	.2
Total	439	100.0

TABLE 15

HOME CA	WORK CA	#WORKERS TRAVELLING	%TRANSIT USERS
25	28	2057	33.6
30	28	1198	31.0
43	28	1532	35.6
49	28	1081	29.0
67	28	1097	37.7
77	28	1075	41.8

Table 15 adapted from Northeastern Illinois Planning Commission report on Cross Town Work Travel Patterns: 1980 Census.

Communities With More Than 85% Minorities

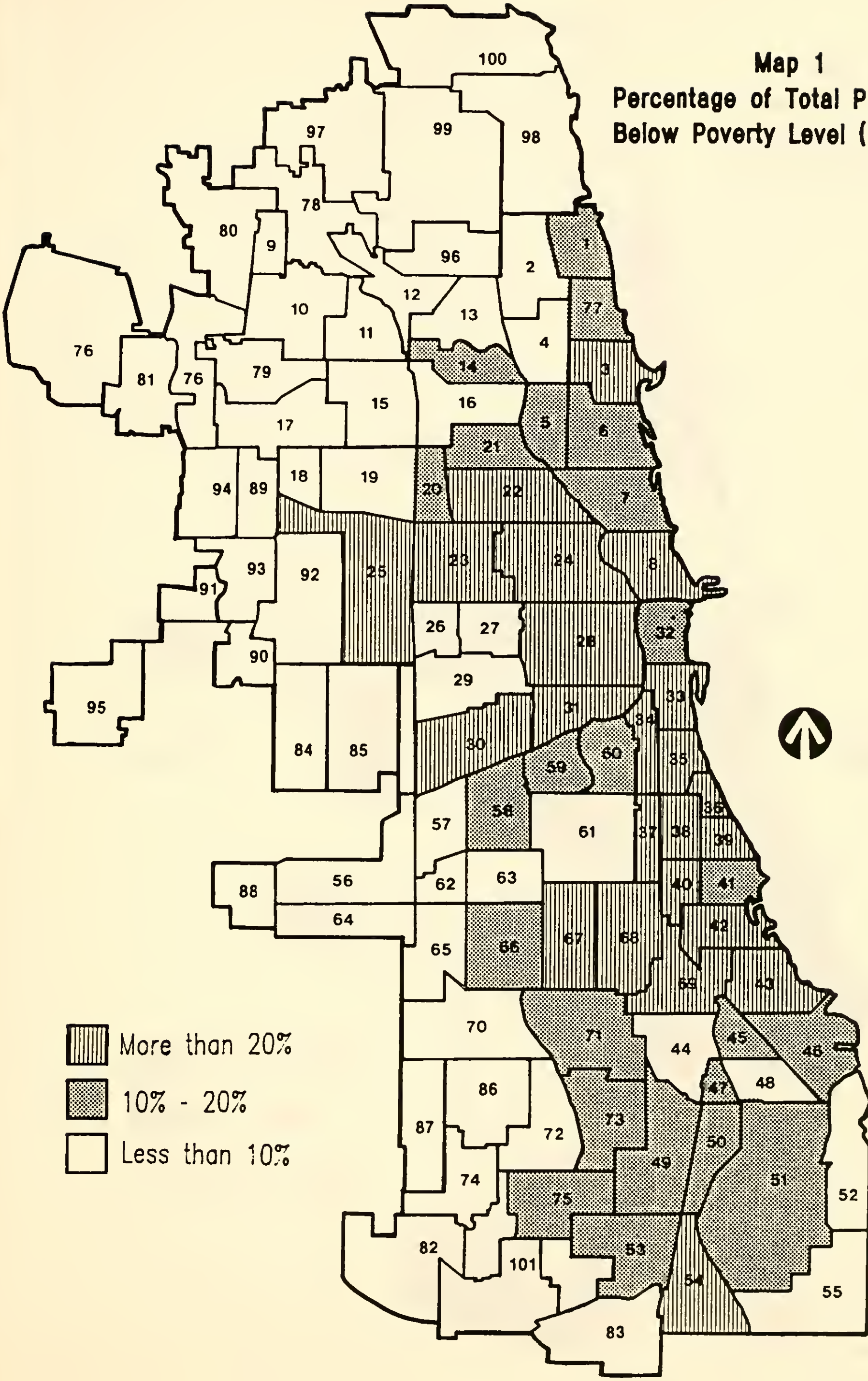
TABLE 16

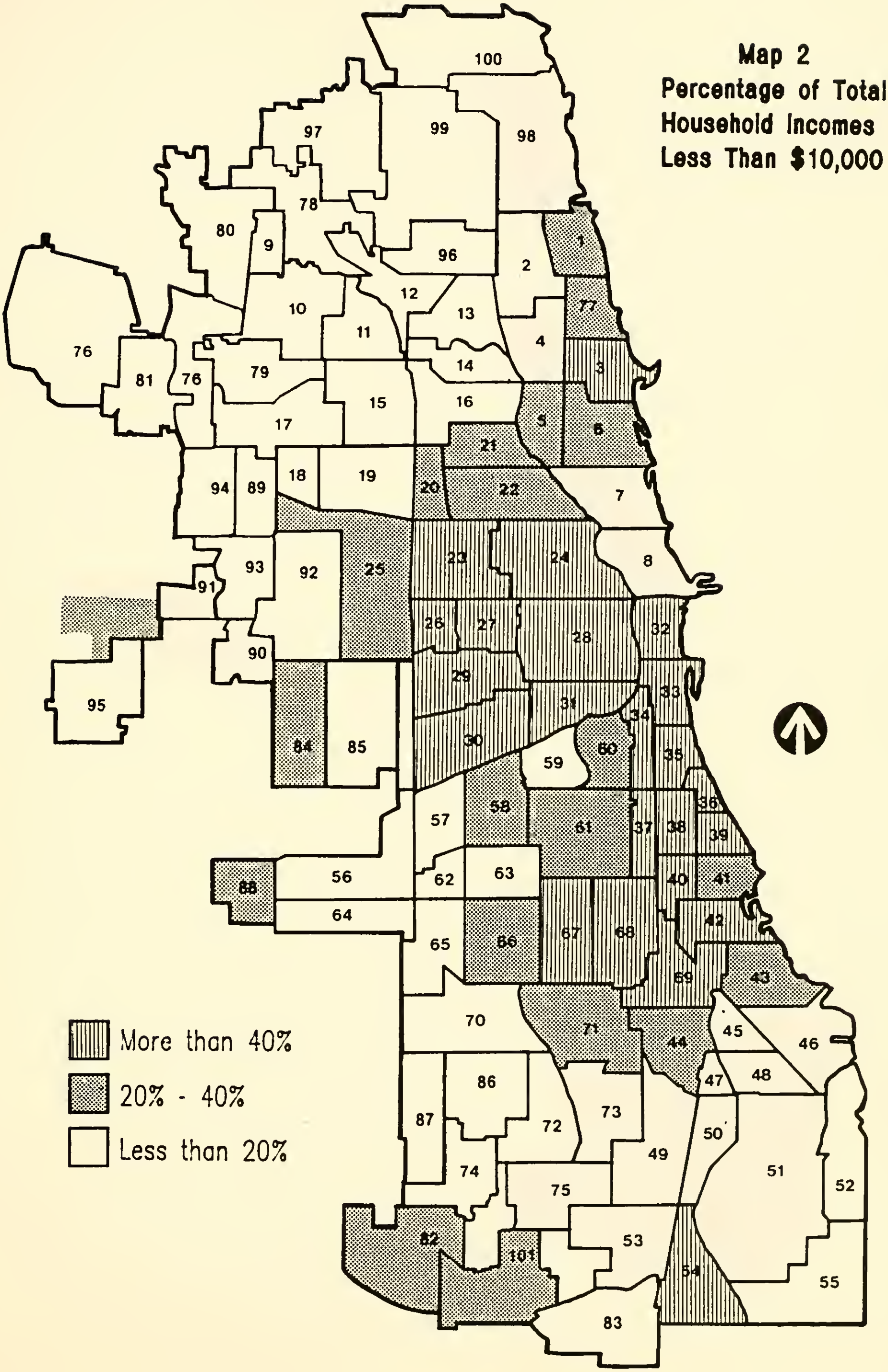
CA	Percentage using transit
26	34.5
27	41.5
28	33.9
29	35.0
33	52.6
35	40.6
36	49.0
37	44.6
38	54.7
40	53.3
42	44.0
43	38.7
44	38.5
45	30.9
47	31.1
48	36.3
49	32.4
53	28.7
67	38.7
68	45.2
69	39.5
71	34.8
73	28.8

TABLE 17

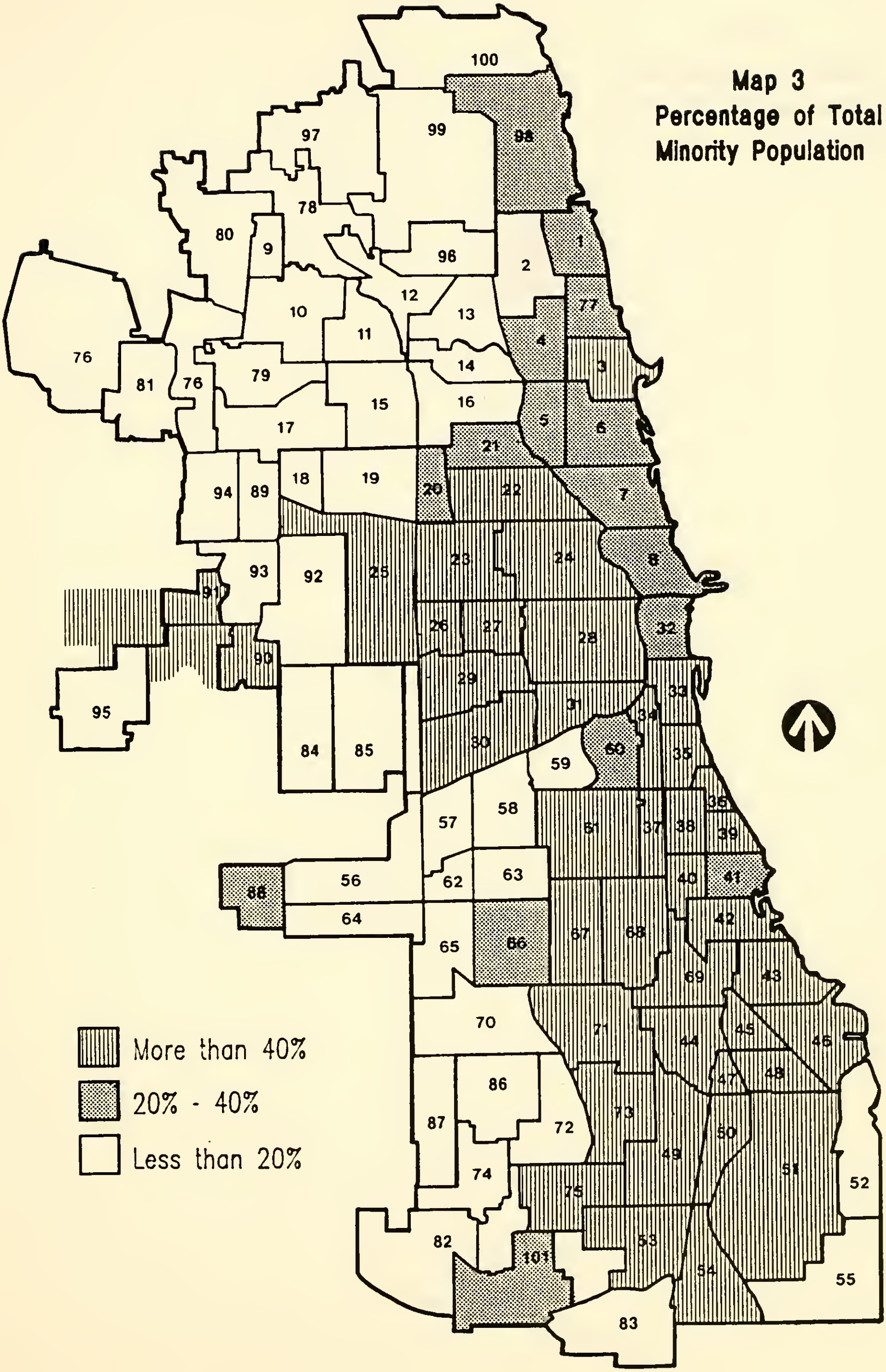
	Less than $10,000
TRANSIT (TOTAL)	41.2%
Bus and Streetcar	47.5
Subway	33.4
Commuter Rail	15.6

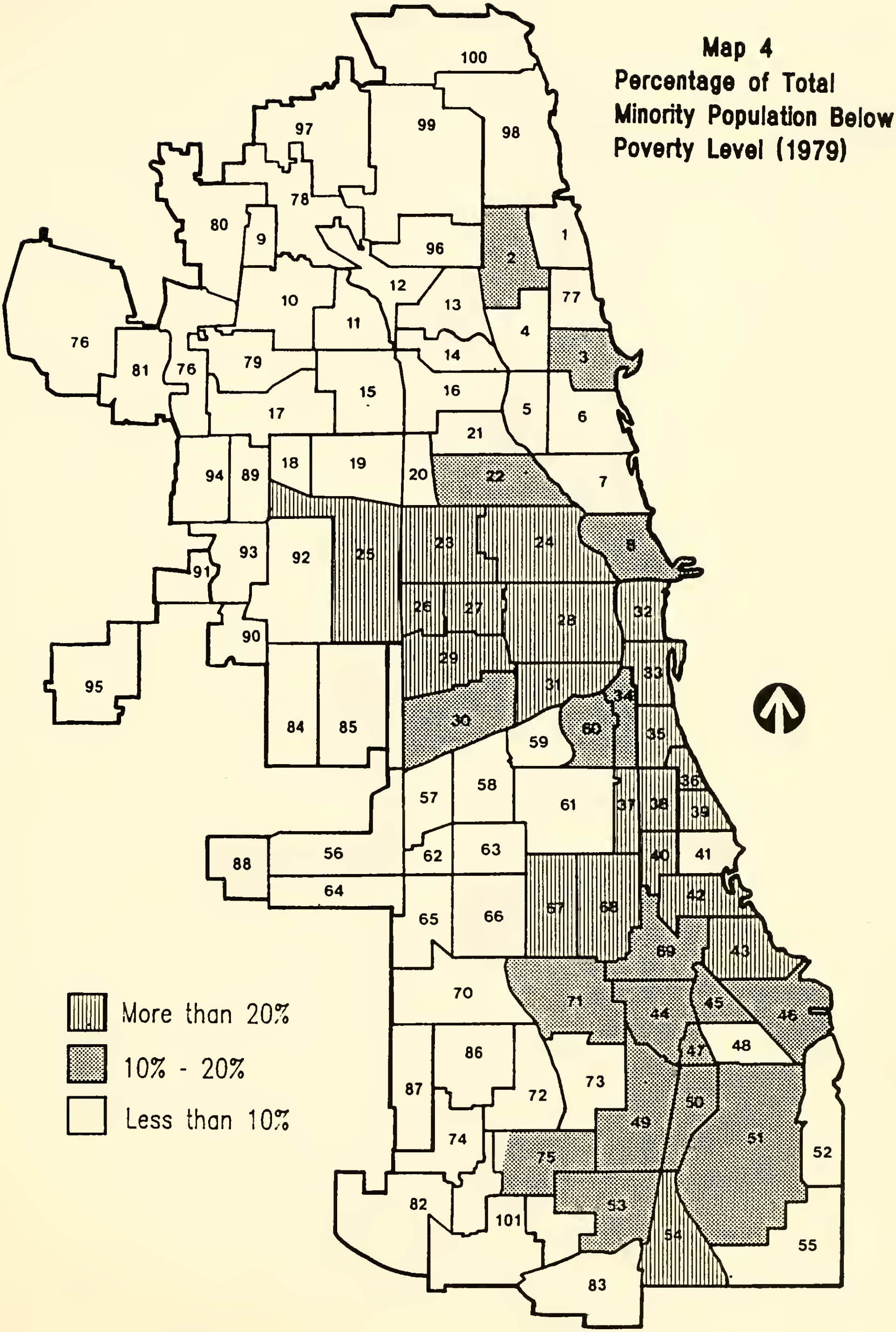
Map 1
Percentage of Total Population Below Poverty Level (1979)



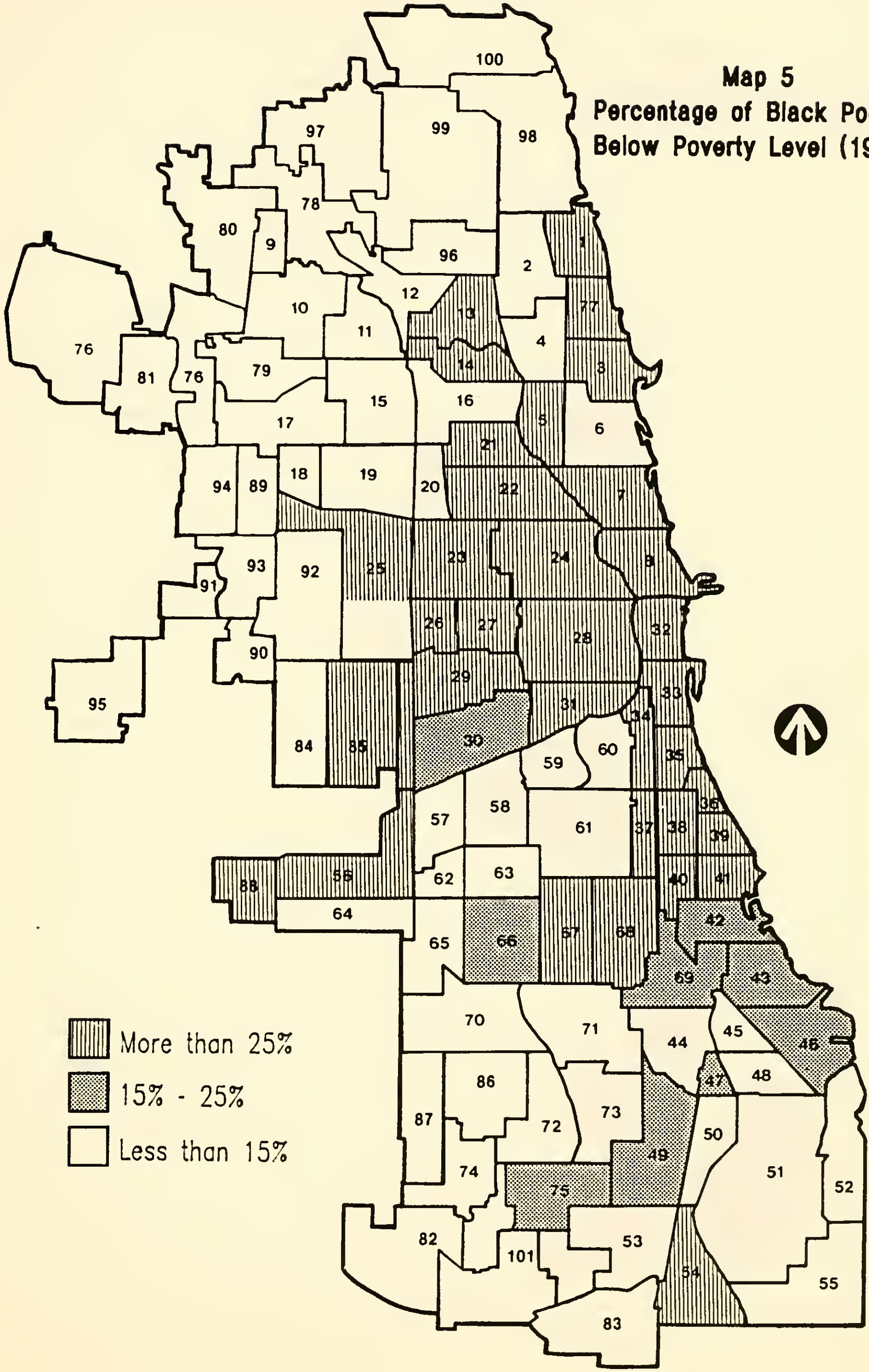

Map 2
Percentage of Total
Household Incomes
Less Than $10,000
More than 40%
20% - 40%
Less than 20%

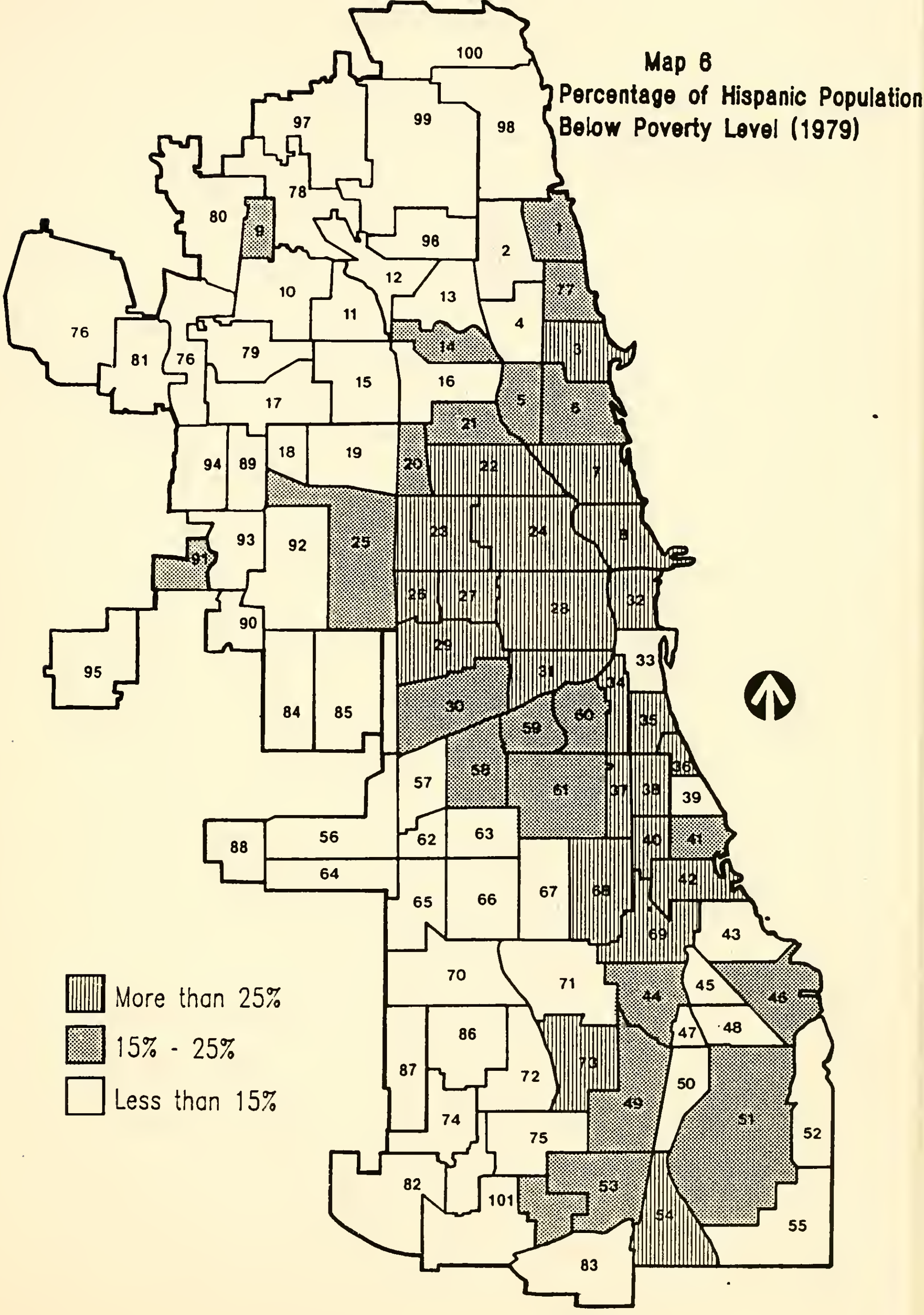
Map 3
Percentage of Total Minority Population



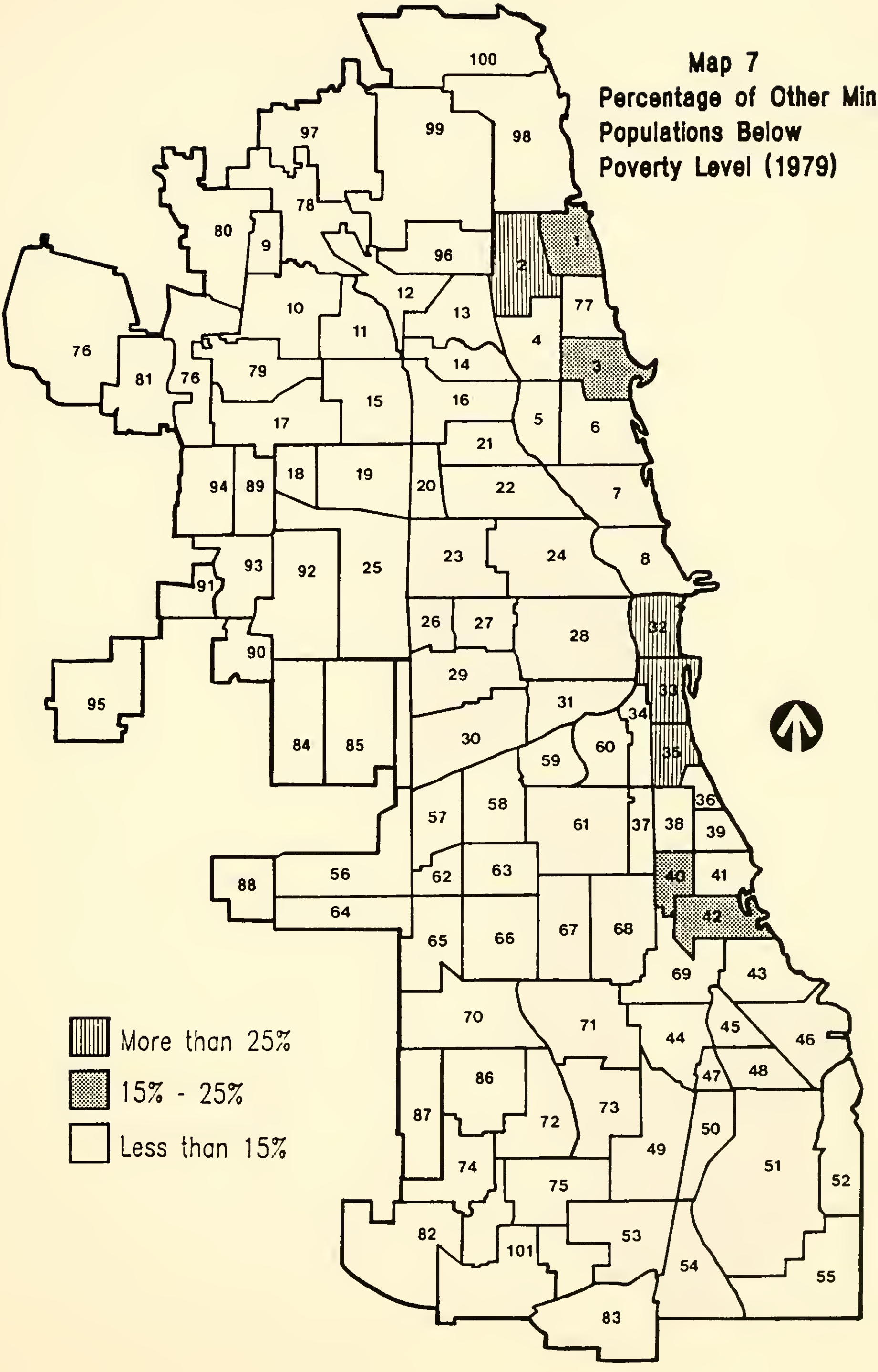

Map 4
Percentage of Total
Minority Population Below
Poverty Level (1979)
More than 20%
10% - 20%
Less than 10%

Map 5
Percentage of Black Population Below Poverty Level (1979)



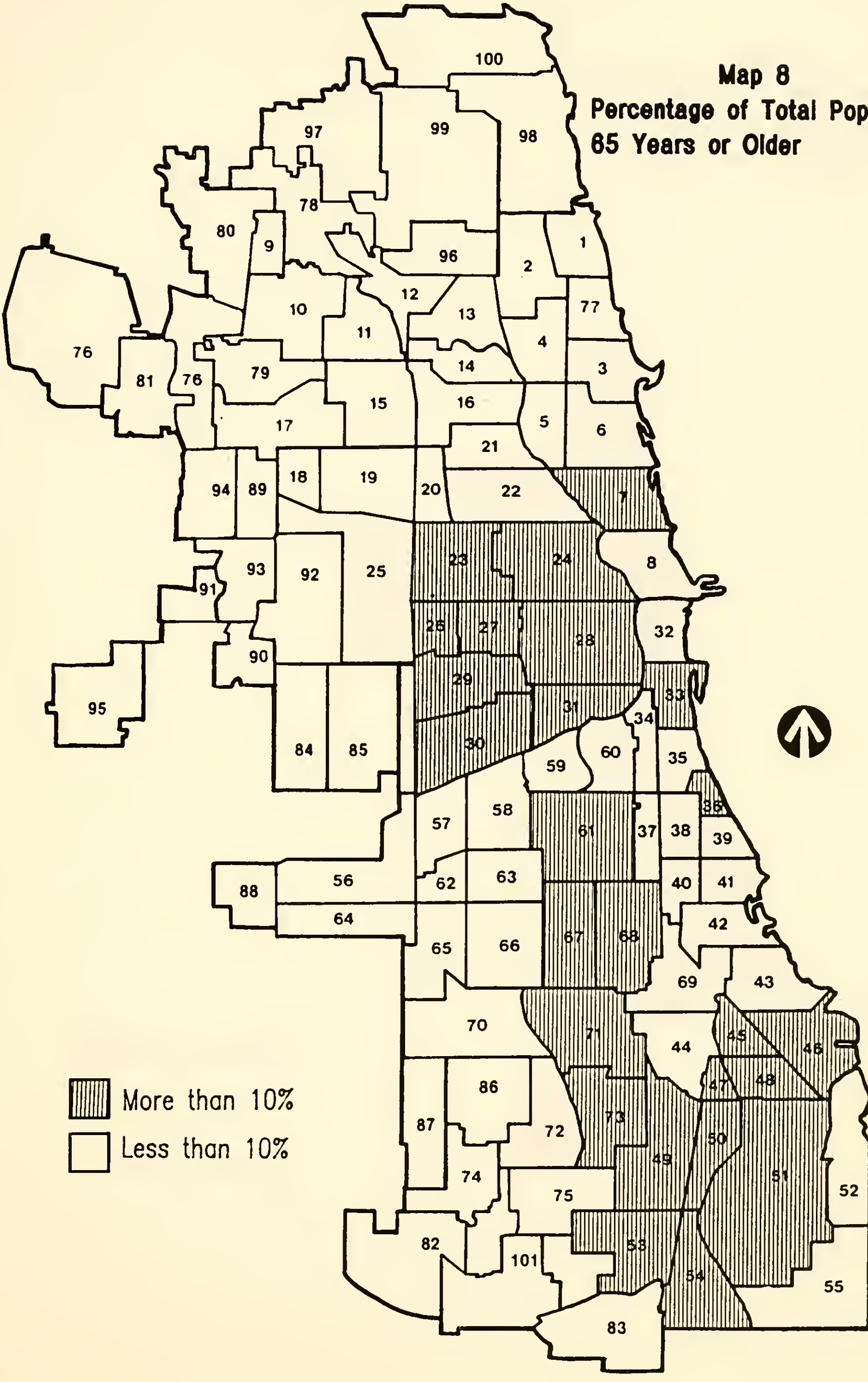


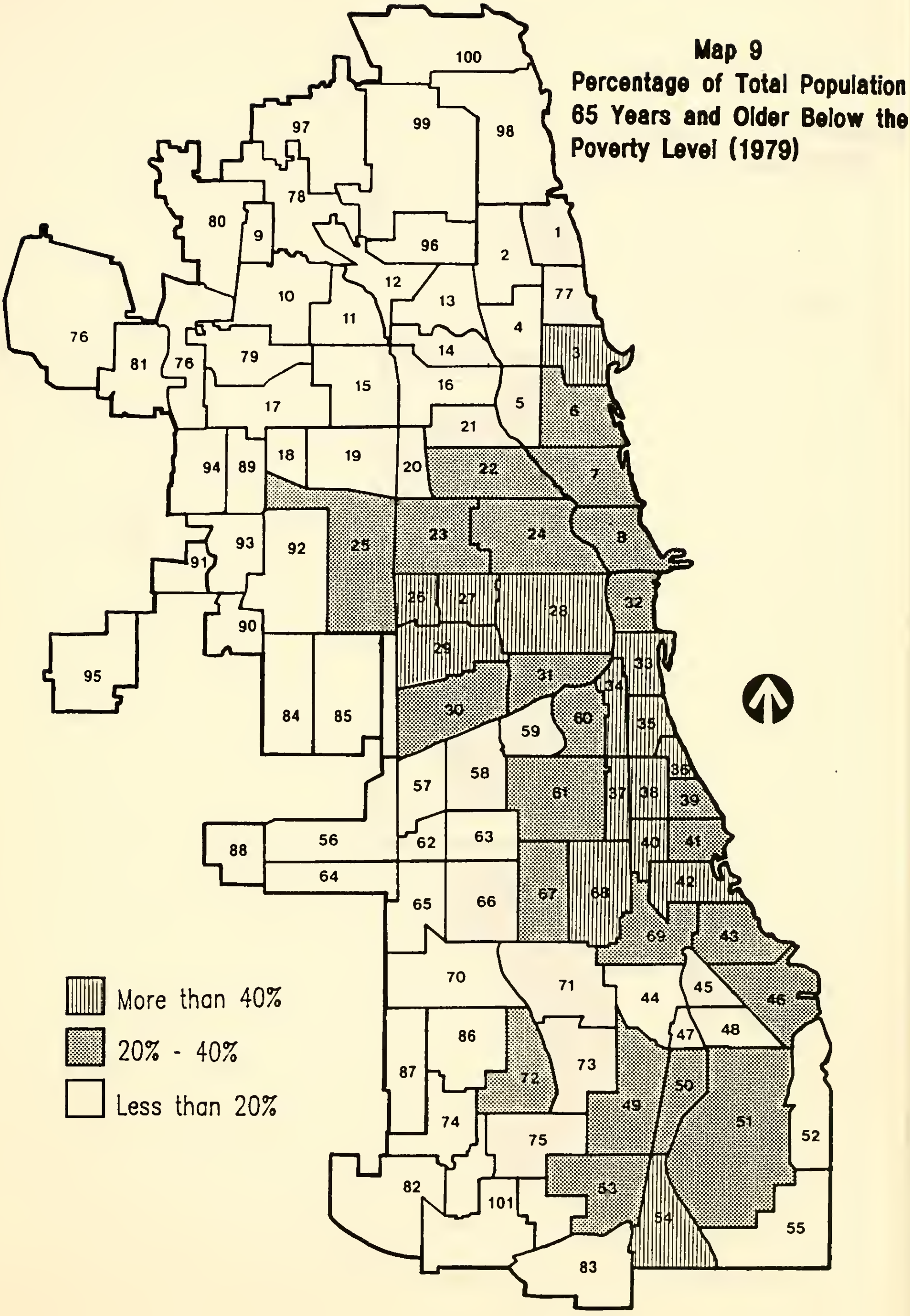
Map 6
Percentage of Hispanic Population Below Poverty Level (1979)



Map 7
Percentage of Other Minority Populations Below Poverty Level (1979)

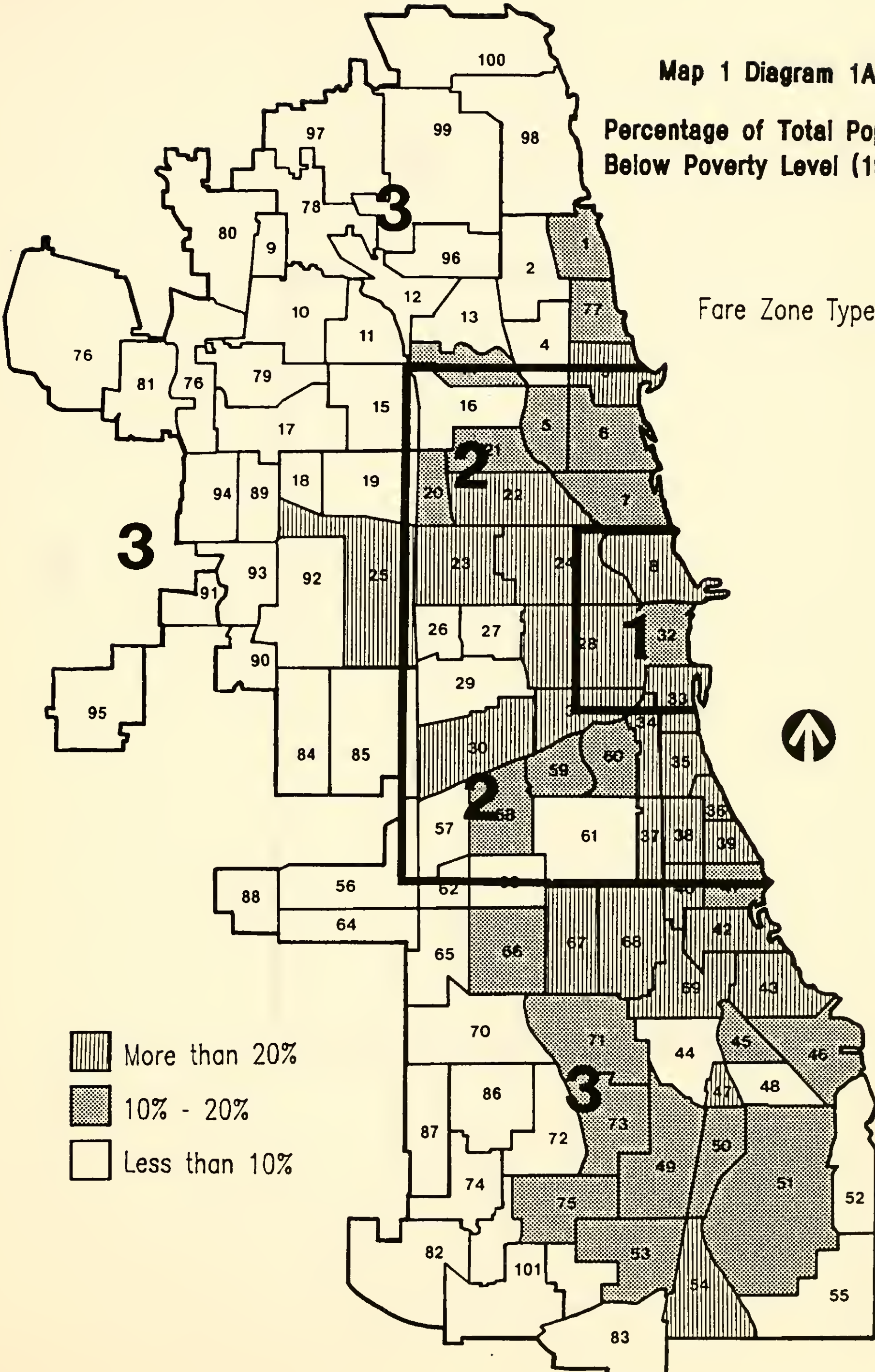
Map 8
Percentage of Total Population 65 Years or Older

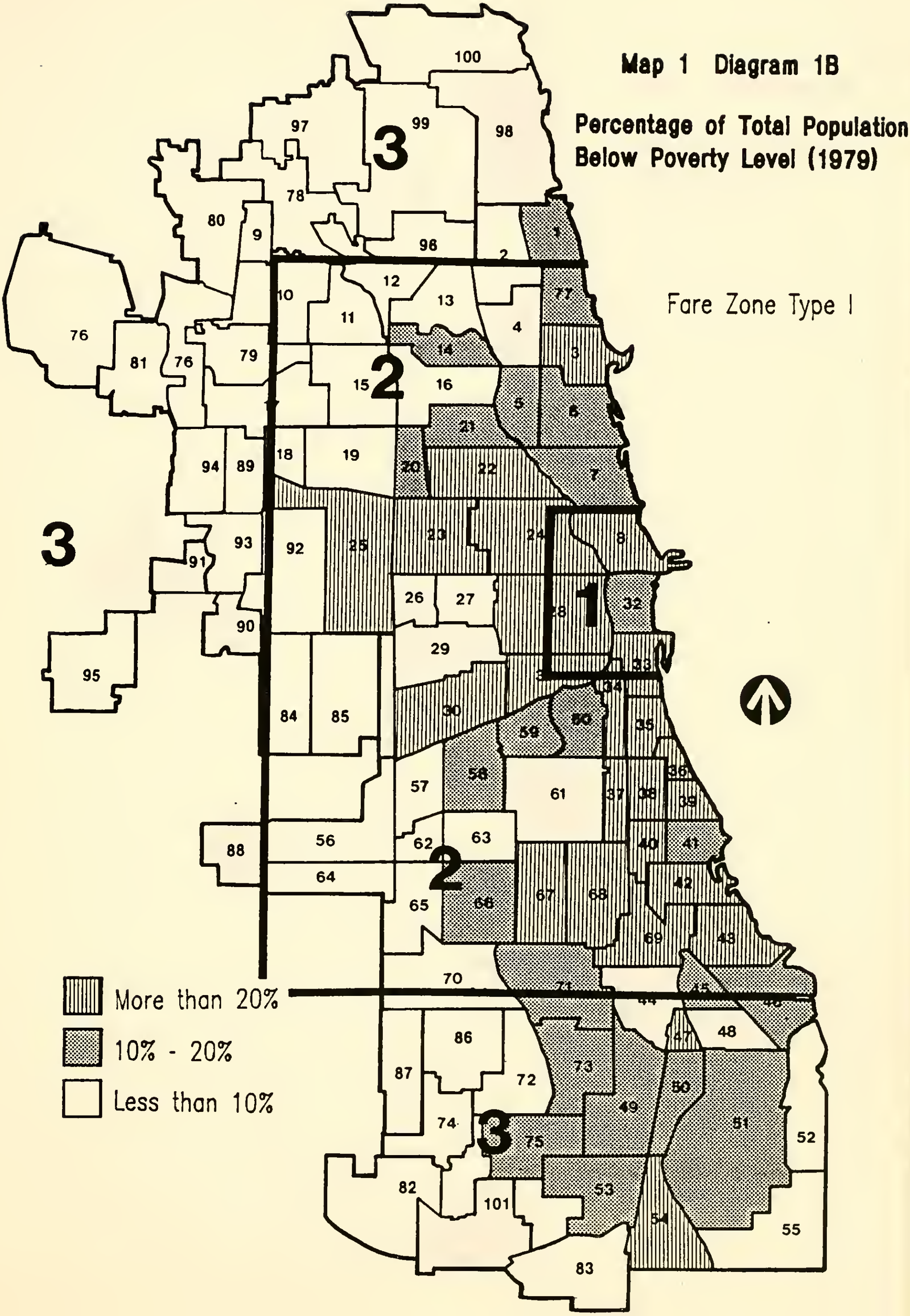



Map 9
Percentage of Total Population 65 Years and Older Below the Poverty Level (1979)
More than 40%
20% - 40%
Less than 20%

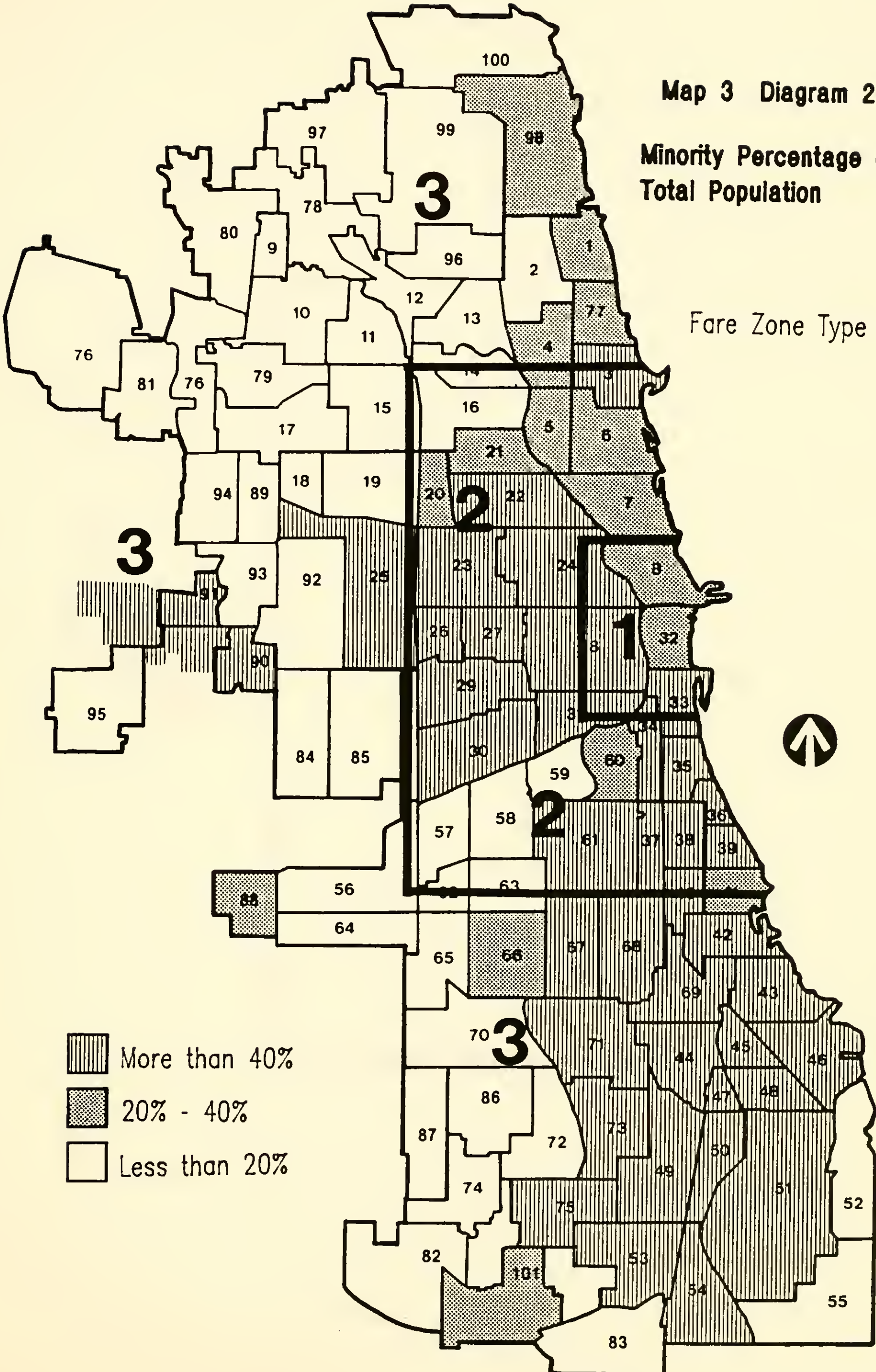
Map 1 Diagram 1A

Percentage of Total Population Below Poverty Level (1979)



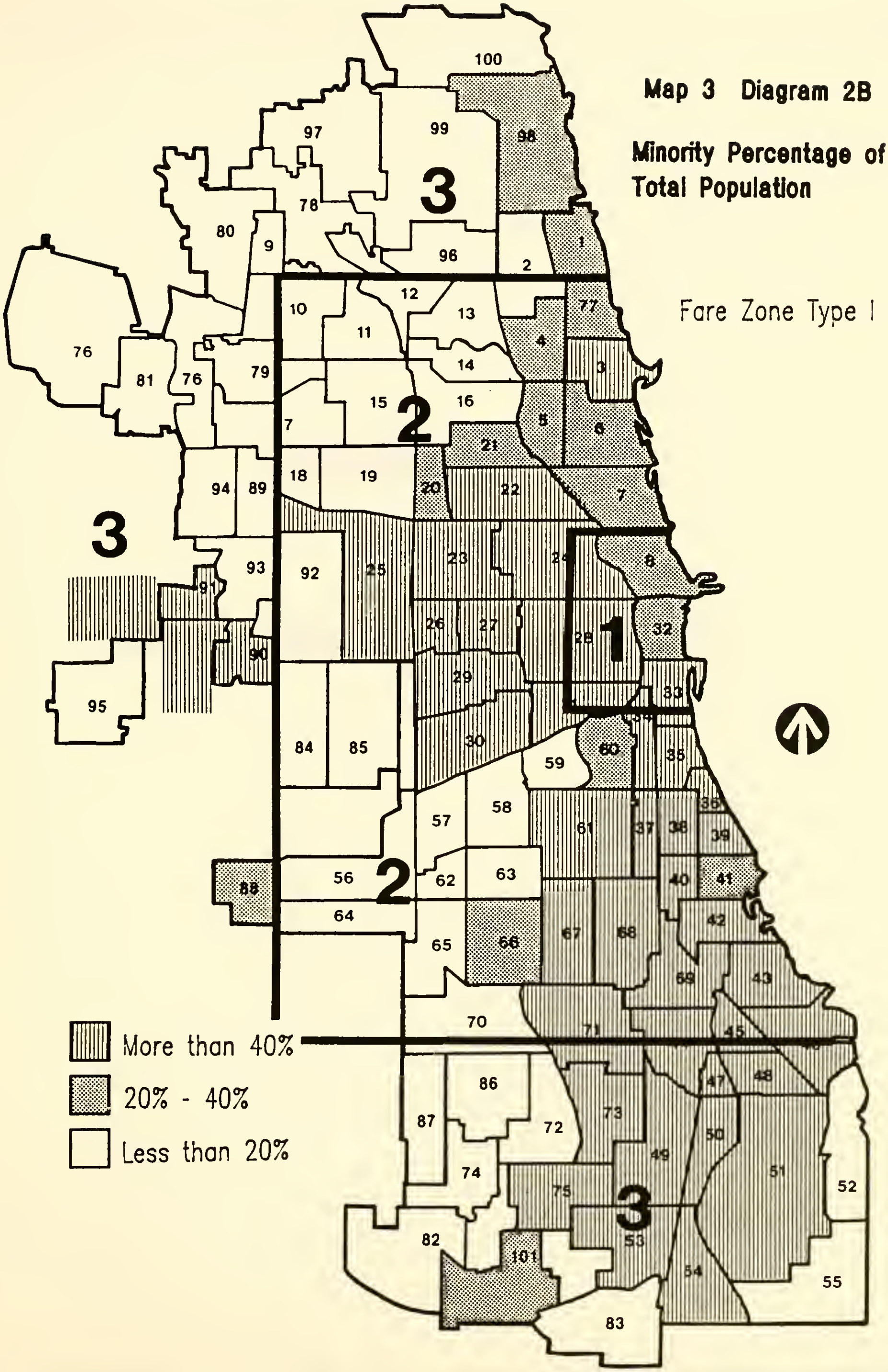


Map 1 Diagram 1B
Percentage of Total Population Below Poverty Level (1979)
Fare Zone Type I
More than 20%
10% - 20%
Less than 10%



Map 3 Diagram 2A

Minority Percentage of Total Population



Map 3 Diagram 2B
Minority Percentage of Total Population
Fare Zone Type I
More than 40%
20% - 40%
Less than 20%
1
2
2
3
3
3

APPENDIX C

DESCRIPTION OF DEMAND MODEL

APPENDIX C

DESCRIPTION OF DEMAND MODEL

As part of the evaluation of options, it was necessary to estimate the effects on revenue and ridership which would occur as a result of the changes in fare associated with each option. This was achieved by using a demand model which was formulated on the basis of data collected in the stated preference trade-off survey as well as some existing data.

1. APPROACH

Two approaches were possible for the model formulation.

- A direct demand model based on transit data only and would not be concerned with the origin of changes in non-transit traffic.

- A modal split model to explain sensitivity to fare change explicitly in terms of the relative competitive position of transit services to other modes.

Both demand and cost estimates for options needed to be at a consistent level of reliability.

- It was inappropriate to attempt to adopt a level of sophistication inconsistent with the reliability of the data available or which could be collected at reasonable cost.

- A level of accuracy was needed that would enable the evaluation of options to be sufficiently robust, yet could be achieved within the scope of the study.

It was necessary to estimate the sensitivity to fare change in each market segment. Given the absence of existing information regarding sensitivity to fare at this level of disaggregation, a modal split approach would be necessary to take account of factors such as transit's competitive position in each market.

- o Sensitivity to fare change would be estimated explicitly using all factors considered to have an influence.
  - This would require a framework beyond the capabilities of a direct demand approach.

Because there had been no history of differential fares by market on CTA's services, and no experience of ridership response to such changes, the study needed additional data.

- o This was collected using a stated preference survey, to achieve the required level of market disaggregation at relatively low cost.

The interaction between the required level of sophistication of the demand model and the reliability of the data which could be expected from the kind of surveys which would be practical in Chicago was recognized.

- o A binary approach was adopted in which it was assumed that riders had a choice of only two alternatives.
- o One of these was transit, defined to include both bus and rail services.
  - It was decided not to distinguish between bus and rail because many passengers regard CTA's services as an integrated transit system.
- o For journeys to work, the model was based on a single binary choice between transit and car, where the latter included both driver and car share.
  - Walk and taxi journeys were ignored because their mode share was sufficiently small to be insignificant.
- o For non-work journeys, it was clear that a single binary choice would not be sufficient because riders have more alternatives.
  - The model assumed that transit was competing in three markets and for simplification each market was considered to be independent.

- Transit was assumed to compete with either car, walk or not travel.

From the data collected by the surveys, estimates of fare parameters were derived for each of the trade-off situations outlined above. During the analysis, the data were disaggregated by the following market segments:

- Peak versus off-peak
- CBD versus non CBD
- Distance (3 bands)
- Car ownership

Sensitivity to fare change was derived as a function of transit market share in each market segment, using these fare parameters and the journey data described in Section VII.

2. MODEL STAGES

Rather than attempt to include all model functions within a single structure, a number of sub-models were formulated which, at least initially, could be maintained and operated separately. This would enable each sub-model to be validated easily and permit a better understanding of the sensitivities involved. The modelling process was divided into four stages each of which had a clearly defined function.

- Stage One: Matrix Manipulation
  - Journey data were extracted and manipulated to derive market segments and transit market shares.
- Stage Two: Base Fare Manipulation
  - Average base fares for each market segment were derived. The effect of pass fare discount on pass take-up was modeled.
- Stage Three: Mode Split Model
  - Fare parameters from surveys and market share data were used to derive fare elasticity values for each market segment.

- o Stage Four: Direct Demand Model
  - Segment fares elasticities and base transit journey data were used to estimate changes in ridership and revenue.

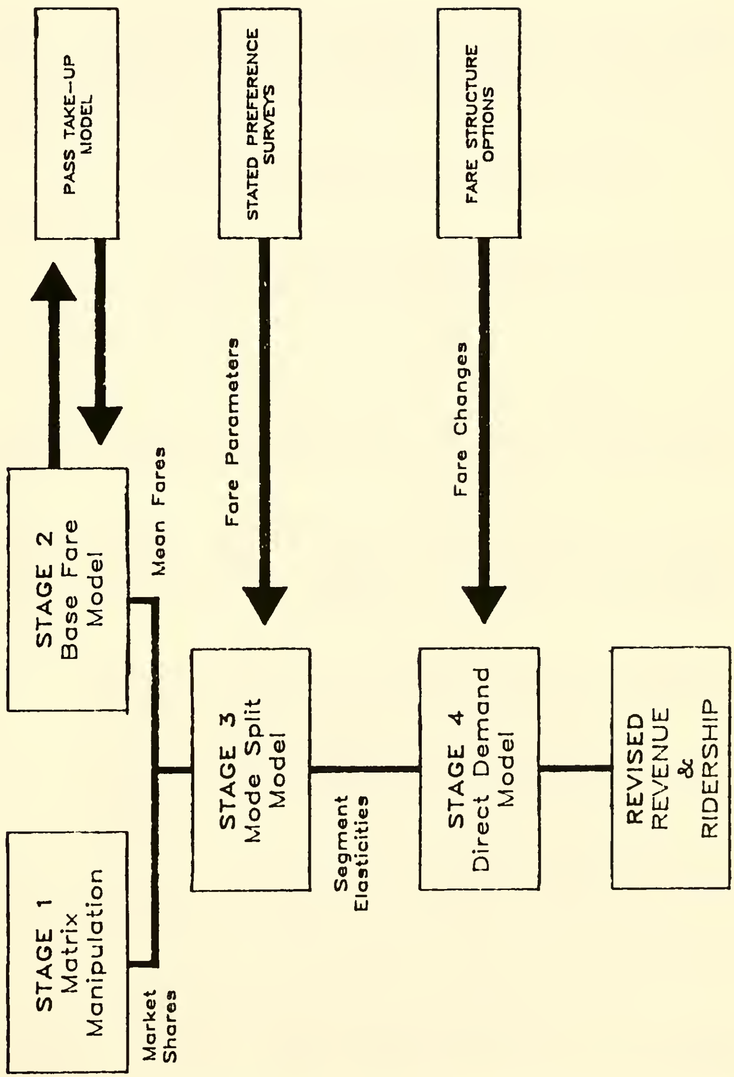
Figure 1, following this page, shows the overall structure of the stages of the model

(1) Stage 1 - Matrix Manipulation

This stage involved the extraction of the journeys data from the various sources and structured the data in a form required by the demand model.

- o Journey data were extracted in the form of 12 by 12 zone matrices for peak and off-peak; bus, rail and car.
- o Journeys of less than 2 miles were extracted as a separate market.
- o The remaining journeys were categorized into 6 geographical market segments as follows:
  - Central
    Journeys entirely within the Central Fare Zone
  - Inner Radial
    Journeys between the Inner and Central Fare Zone
  - Outer Radial
    Journeys between the outer and Central Fare Zone
  - Inner Local
    Journeys entirely within the inner Fare Zone
  - Outer Local
    Journeys entirely within the outer Fare Zone
  - Cross Boundary Local
    Journeys between outer and inner Fare Zones

APPENDIX C
Figure 1
MODEL STRUCTURE



The market segments were based on the three fare zones established to evaluate the zonal options. These were formed by aggregating the 12 study area zones as follows:

- Central Fare Zone
  - The central area including zones 1 and 2
- Inner Fare Zone
  - The inner semi-circle immediately surrounding the central Area including zones 3 to 7
- Outer Fare Zone
  - The outer semi-circle including zones 8 to 12.

The origin-destination pairs were assigned to one of the six market segments according to the number of fare zones traversed.

- For example, journeys between Evanston and 95th Street which start and end in the same fare zone (i.e., Outer Fare zone) would traverse all three fare zones and be assigned to the "Outer Radial" market.
  - The process of assignment needed a degree of judgment since no data existed providing routes between origin and destination.
  - However, the number of journeys in this category was relatively small so that errors introduced due to mis-classification would be minimal.

The study adopted two alternative zoning systems to estimate the effects of moving the boundary between the inner and outer fare zones.

- Figures 2 and 3 show the two alternative configuration of study zones and the three fare zones.
- Figures 4 and 5 show the distribution of journeys between the six market segments for the two zoning systems.

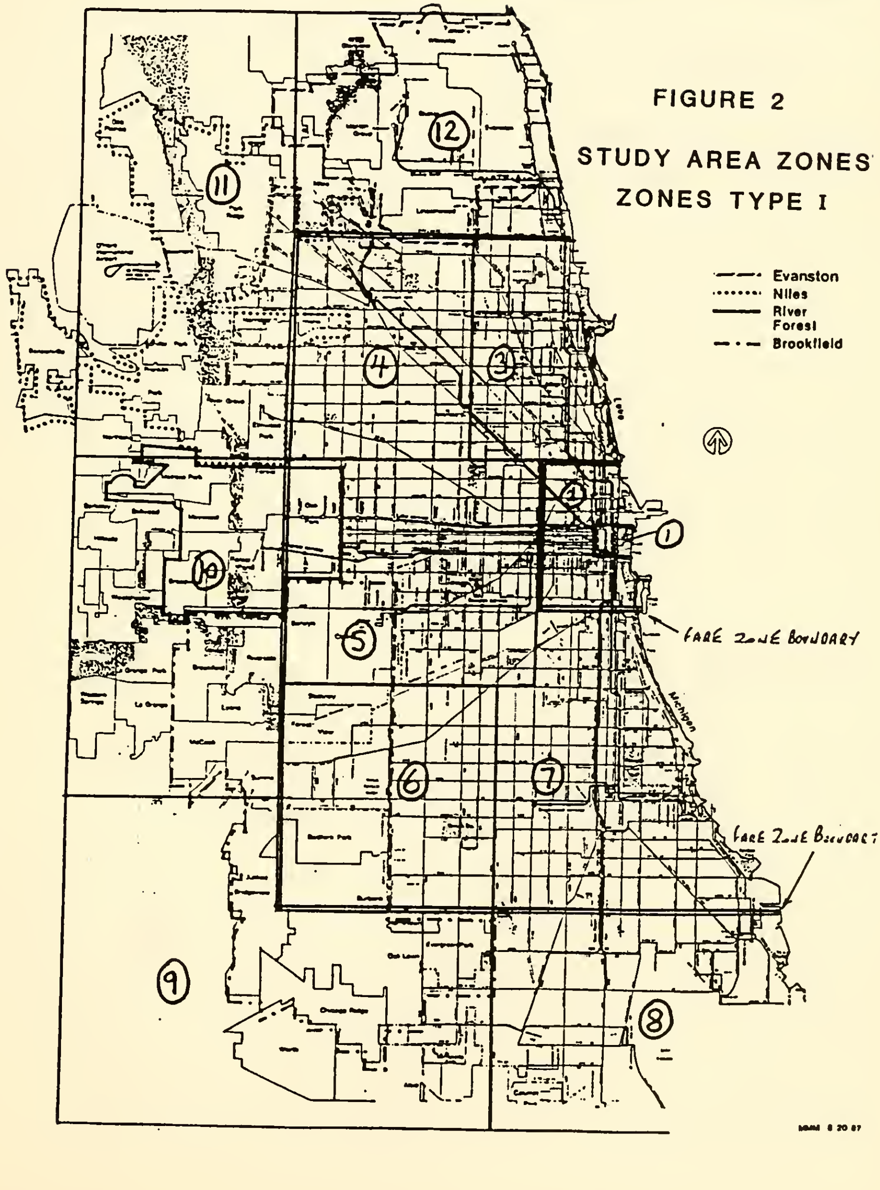


FIGURE 2
STUDY AREA ZONES
ZONES TYPE I
Evanston
Niles
River Forest
Brookfield
1
2
3
4
5
6
7
8
9
10
11
12
FARE ZONE BOUNDARY
FARE ZONE BOUNDARY
Michigan

Fares Demonstration Study
Final Report - Appendix C
CHICAGO TRANSIT AUTHORITY
UWP # 4325.34

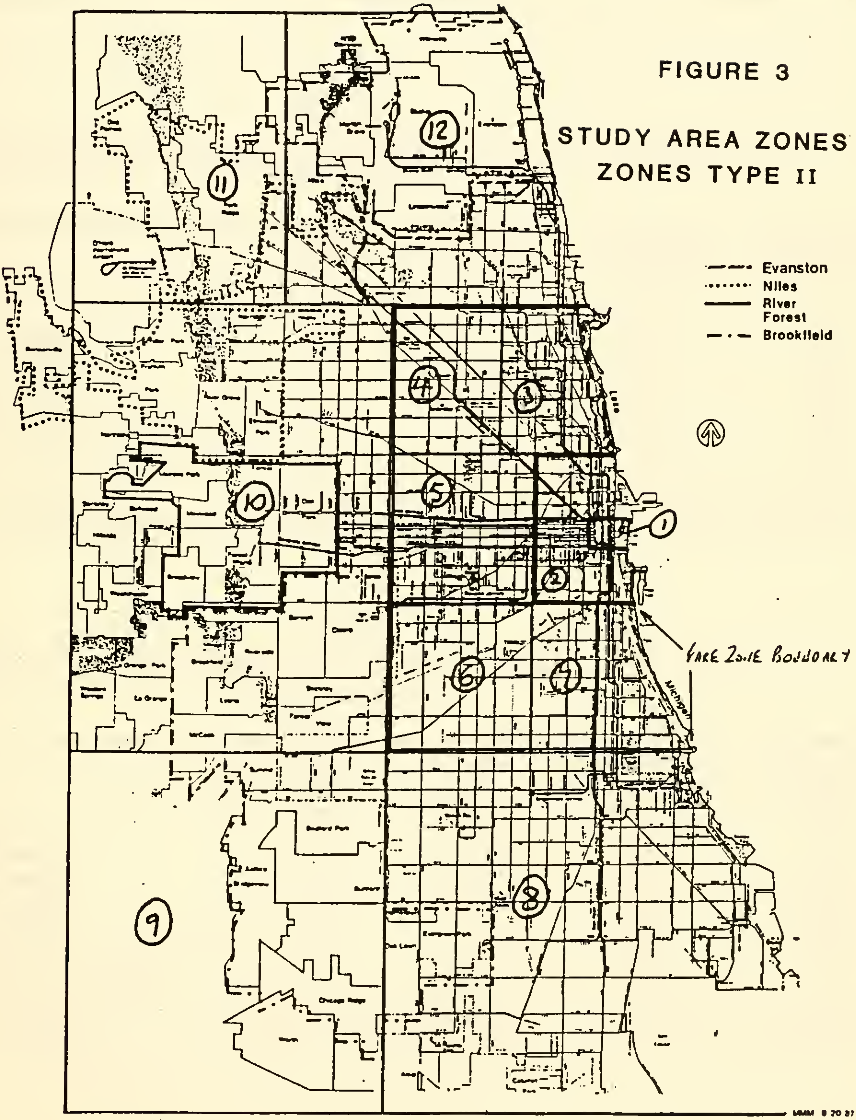


FIGURE 3

STUDY AREA ZONES
ZONES TYPE II

FIGURE 4

DISTRIBUTION OF JOURNEYS BY MARKET SEGMENT. (ZONE TYPE 1)
(PERCENTAGES)

	PEAK BUS	PEAK RAIL	OFF-PEAK BUS	OFF-PEAK RAIL
Central	0.2	0.2	0.3	0.2
Inner Radial	40.0	45.9	30.0	37.5
Outer Radial	6.8	16.3	3.6	10.7
Inner Local	6.8	8.0	22.1	22.0
Outer Local	1.1	1.0	1.1	1.1
Cross Boundary Local	19.2	17.5	7.4	10.2
Less than 2 Miles	26.2	11.0	35.5	18.2
TOTAL	100.0%	100.0%	100.0%	100.0%

FIGURE 5

DISTRIBUTION OF JOURNEYS BY MARKET SEGMENT. (ZONE TYPE 2)
(PERCENTAGES)

	PEAK BUS	PEAK RAIL	OFF-PEAK BUS	OFF-PEAK RAIL
Central	0.2	0.2	0.3	0.2
Inner Radial	24.0	19.7	18.8	17.8
Outer Radial	22.5	42.6	14.8	30.4
Inner Local	5.2	4.7	6.0	6.4
Outer Local	8.9	7.7	10.1	10.2
Cross Boundary Local	12.9	14.1	14.4	16.7
Less than 2 Miles	26.2	11.0	35.5	18.2
TOTAL	100.0%	100.0%	100.0%	100.0%

  - These demonstrate the effect of moving the boundary between the inner and outer fare zones on the size of each market segment.

  - Type I zone system has the boundary approximately 8-9 miles from the Loop at Devon, Harlem and 87th Street.

  - Type II zone system has the boundary approximately 5 miles from the Loop at Lawrence, Cicero and 55th Street.

- For Type I zones, only about 7 percent of peak rail and 16 percent of peak bus journeys fall in the outer radial market whereas the equivalent shares for the inner radial market are 50 and 56 percent respectively.

- For Type II zones, the size of the outer Fare zone is increased and the inner fare zone reduced the balance between the two radial markets is improved (rather more so for rail rather than bus).

The optimum boundary location probably lies between the two examples. The study demonstrated the effect of alternative zone configurations rather than identifying the definitive arrangement.

For each market segment, the mode share represented by transit was derived.

- For journeys of less than two miles, it was assumed that in the off-peak, walk would be a competitive mode.

  - In the absence of other data covering walk journeys, it was assumed that the market share represented by walk journeys in the activity center survey would be representative of CTA's service area as a whole. This was taken as the base market share in the model.

Rather than assume that the base probability of using transit was equal to the base mode share for transit, two adjustments were made:

- In the outer zones, there were a number of areas which had poor accessibility to CTA services, being distant from any bus or rail route.
  - It was likely that many journeys from these areas by car would face very little competition from transit services; such that these journeys were excluded from the estimation of base probability of transit use.
  - The outer zones were segmented on the basis of the area within 3/8 mile of CTA services (as defined in CTA report to UMTA entitled "Service Delivery - Compliance with Title VI of the 1964 Civil Rights Act").
- The second adjustment took account of the level of car availability. Data were extracted from the 1979 Origin and Destination Survey corresponding to the question "Did you have an automobile or other private vehicle available for this trip?".
  - The proportion of car-available journeys was factored to account for the growth in car ownership between 1979 and 1986.
  - The proportion of non-car available transit journeys was then used to factor the base probability of using transit.

(2) Stage Two: Base Fare Manipulation

The purpose of this stage was to derive an average base fare for each market segment and to estimate the effect of changes in the relative price of pass and cash fare journeys. The steps may be summarized as follows:

- Average single stage and multi-stage cash fare, calculated for bus and rail journeys.
  - This is based on the various fare categories and number of fares collected in each category.

- o Average pass fare derived.

  - Based on the fare per stage (pass-revenue divided by the number of rides registered) and the number of stages per journey estimated from the 1986 Trip Component Survey.

- o Average bus and rail fare per journey calculated by taking a weighted average of cash and pass fares.

  - This assumed bus and rail pass fares were equal. At this stage, the model included a pass take-up formulation, which allowed for a change in the relative price of pass and cash journeys in determining the level of pass take-up and the mean fare.

- o Proportion of multi-stage fares as a function of distance derived based on 1979 Origin Destination Survey.

  - This was done by extracting the proportion of transfer fares at each distance band (see Figure 6 following this page).

- o Average fare estimated for the three distance bands up to 2 miles, 2 to 6 miles, and over 6 miles for bus and rail.

The function of the pass take-up model was to estimate the effect of a change in the relative price of pass and cash journeys on the level of take-up of passes.

- o This determined the average cash/pass fare used in subsequent stages of the model. The model assumed the following:

  - The level of take-up is directly proportional to the level of discount of pass fares relative to cash fares.

By plotting a graph of the change in discount which occurred over the last three fare increases against the level of take-up, a straight line is produced (see Figure 3, Appendix A2 and preceding text) implying the following relationship.

FIGURE 6

TRANSFER JOURNEYS VERSUS DISTANCE

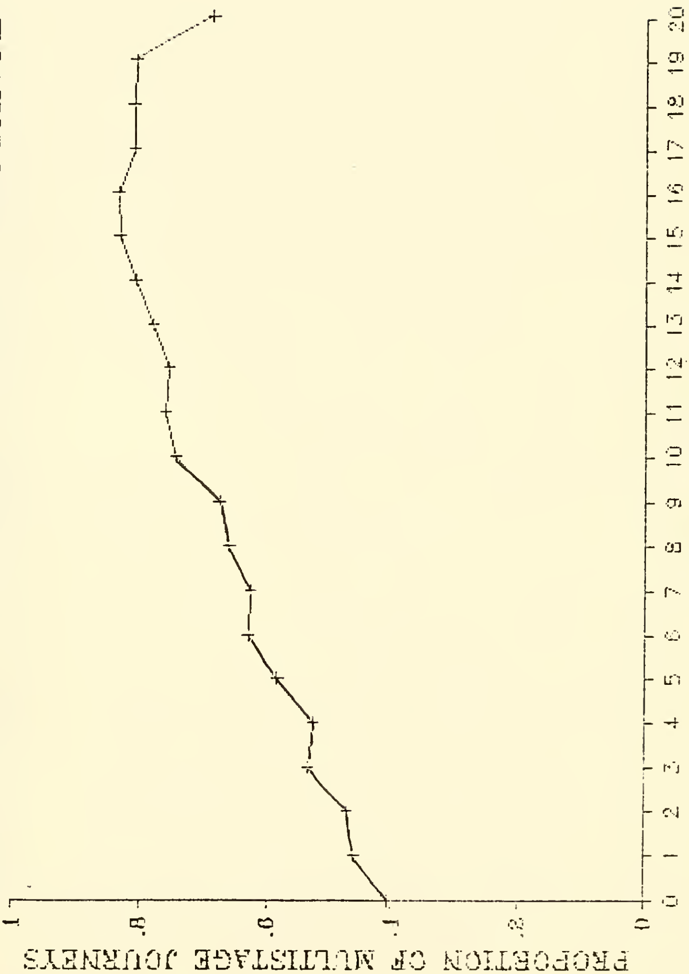
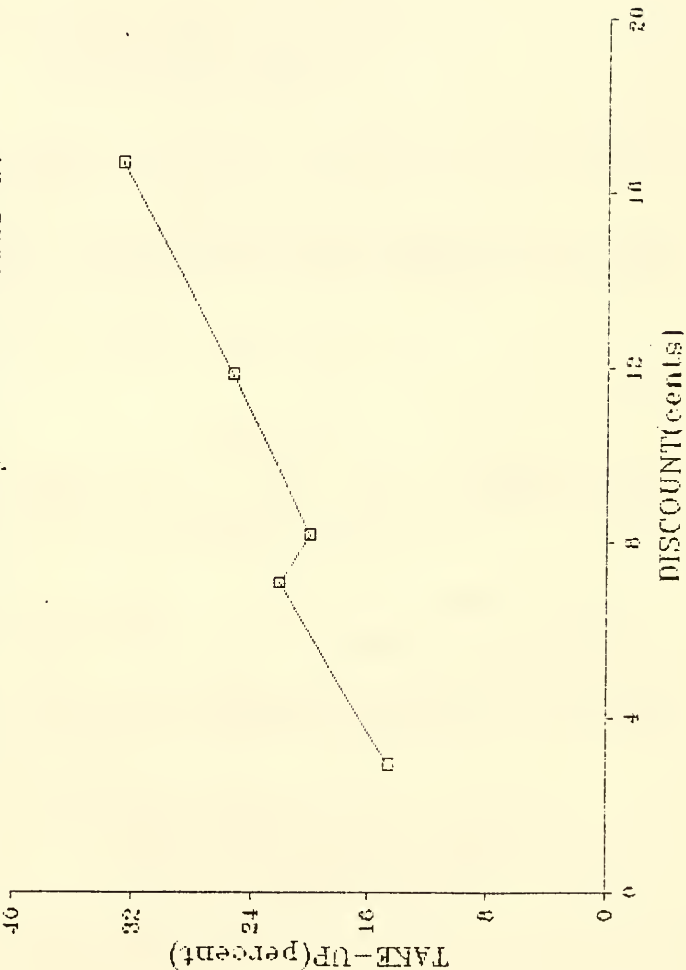


FIGURE 7

PASS TAKE-UP VERSUS FARE DISCOUNT

Source:CTA Monthly Statistics 1981-87



Revised Take-up (TU2)
= Base take-up (TU1)+0.014
x (Revised Discount (D2)
- Base Discount (D1)

- All cash journeys which transfer to pass journeys could make additional journeys at no extra cost to the passenger.

Extra journeys are generated by assuming that the traffic transferring from cash to pass (QPC) benefit from a reduction in fare equivalent to 100 percent and by assuming a fares elasticity of 0.3.

i.e., Generated traffic $= QPC \times \frac{\Delta F}{F} \times 0.3$

$= QPC \times 0.3$

- This generation of trips may be expressed as a generation growth factor (GGF). This is a function of the change in take-up as follows:

$$GGF = \frac{1 + 0.3 \times (1-TU1)}{1 + 0.3 \times (1-TU2)}$$

where TU1 = Base take-up

TU2 = Revised take-up

- The number of trips made per pass decreases as the level of discount increases according to the following formulation:

  Revised trips per pass

  $$= \text{Base trips per pass} \times \left[\frac{\text{Base cash/Pass Ratio}}{\text{Revised cash/Pass Ratio}}\right]^{PUF}$$

  Where PUF = Pass Usage Factor (0.4) determined by calibration.

- The combined number of cash and pass trips would increase or decrease as a function of the change in weighted cash/pass fare, expressed as a Fare Growth Factor (FGF) as follows:

$$FGF = \left[\frac{\text{Revised mean fare}}{\text{Base mean fare}}\right]^{E}$$

Where E = Fares Elasticity

if

Base Mean Fare
= TU1 x Base Pass Fare
+ (1-TU1) x base cash fare

Revised Mean Fare
= TU1 x Revised Pass Fare
+ (1-TU2) x Revised Cash Fare

- o The model was calibrated as far as possible by changing various parameters such as fare elasticity and the pass usage factor until the overall results in terms of trip changes and aggregate elasticity appeared reasonable.

This approach was somewhat arbitrary since more knowledge is required concerning the mechanism which drives the level of take-up.

- o The growth in pass usage is probably a function of not only discount, but also of habit and experience gained by riders once they have decided to buy a pass.

(3) Stage Three - Mode Split Model

The purpose of stage three was to derive values of fares elasticity for each market segment. The fare parameters estimated on the basis of the stated preference surveys were combined with the market share data set up in Stage One.

Since the survey work did not distinguish between bus and rail services, the elasticity values derived were for transit only. The deviation of separate values for bus and rail addressed in Stage Four.

- Values of elasticity were derived corresponding to the average level of fare change which was applicable to each of the options evaluated in Stage Four.

- The modal split model used in this stage of the modelling process was derived from a conventional multinomial logit model expressed as:

$$Pi = \frac{e^{Ui}}{\sum_j e^{Uj}}$$

Where Pi = Probability of traveling by mode i
Ui = Utility of traveling by mode i
j = Set of all competing modes

For this study, a simple binary version of this model was adopted using two competing modes.

- This assumed that transit riders had a choice of either car or walk but not both; their choice was constrained only to the next alternative.

  This simplified model is expressed as:

$$Pt = \frac{e^{Ut}}{e^{Ut} + e^{Uc}}$$

Where Pt = Probability of traveling by transit
Ut = Utility of traveling by transit
Uc = Utility of competing mode

The utility function was defined using the regression equation:

$$U = B_0 + B_1 X_1 + B_2 X_2 + \ldots . B_n X_n$$

Where B_0 = The constant (the aggregate effect on the dependent variable of all variables not included in the equation)

B_1, B_2, etc. = Coefficients describing the effects of the independent variable s such as fare, travel time, etc.

X_1, X_2, etc. = The independent variables

- The method of estimation of the coefficients has been described in the Surveys Report.

If all variables remain constant apart from fare, the model formulation can be simplified to:-

$$\frac{P_2}{P_1} = \frac{e^{B\Delta f}}{1-P_1\ (1-e^{B\Delta f})}$$

Where P_1 = base share using transit
P_2 = revised share using transit
B = estimated fare coefficient
Δf = change in fare

- For work journeys, the model assumed a competition between car (driver or passenger) and transit (bus or rail). Walk journeys were ignored.

- For non-work journeys, the model assumed three separate binary choices (including car, walk and not travel as competing alternatives) which then combined in the following formulation:

Overall Growth Factor $GF = GF_1 \times GF_2 \times GF_3$

Where GF1 = growth factor applied to the car versus transit market
GF2 = growth factor applied to the transit versus walk market
GF3 = growth factor applies to the transit versus not travel market

and in

Which GF was defined as $= \frac{P2}{P1}$ derived for each of the three binary markets.

Values of B were estimated from the trade-off surveys for each of the three trade-off situations accommodated in the activity center survey.

- The base proportion traveling by transit in each market for auto and walk were extracted from both aggregate CATS data (auto) and from the trade-off survey (walk).

- There was no straight-forward means of estimating the base proportion of transit users in the transit versus not travel market.

- This component of the model effectively represented a generation/suppression function.

Different values of P1 were tested to establish its sensitivity, but a value of 0.5 was adopted in the absence of better information.

(4) Stage Four - Direct Demand Model

Stage Four was the last phase of the modelling process. The change in ridership, both in terms of passenger-miles and journeys, was estimated together with the change in revenue associated with each fare structure option.

- o Option 4 (prepayment) which was treated in Stage Two, was not evaluated in this way.

Market segment elasticities and the estimation of the demand effects of options were split into two sub-models.

- o Once the values for elasticity had been estimated using the fare parameters and the market share information, they would remain constant and be carried forward into a separate model.

  - This was valid as long as the values of elasticity were derived to be consistent with the range of the fare change corresponding to each fare option.

  - The elasticity values were used in a direct demand formulation (in Stage Four). This enabled a further dissaggregation of the market segments into bus and rail using the relative elasticity values estimated on the basis of CTA ridership data and Loop Cordon data described in Appendix A2.

The evaluation of options within a separate sub-model, enabled the changes in fare associated with each option to be modeled in detail while limiting the complexity of the model.

- o Direct demand formulation was justified given that it was used at the dissaggregate market segment level, with a separate value of fare elasticity for each market.

The formulation used was:

$$\text{Change in journeys} = \frac{\text{Segment elasticity} \times \text{change in segment Fare} \times \text{base segment journeys}}{\text{Average base segment fare per journey}}$$

The change in passenger-miles was calculated assuming the average journey distance for each market segment remained constant.

- o This is an over simplification since under the distance-based fares options, some riders would continue to travel but reduce their transit journey length to avoid paying a higher fare, and complete their journey on foot. This would occur particularly near fare zone boundaries.

The change in revenue was also calculated at this stage based on the revised number of journeys and the revised average fare.

An additional submodel was formulated (for the Rail Graduated Fares Option) to identify the sensitivity between the course fare scale of the zonal options and a finely graduated scale.

- o This approach was simpler than attempting to formulate a model incorporating both zonal and graduated fare structures.

APPENDIX D

OPTION COSTING

APPENDIX D

OPTION COSTING

OPTION 1 - PEAK/OFF-PEAK

1. For bus, existing GFI fare boxes would be retained, and the keys reassigned so that keys would be used for peak or off-peak periods.

   o In addition the clock within the farebox would be utilized so that fares paid during off-peak periods could be identified separately.

2. The GFI software would also be modified so that fares/ridership data could be printed out by time of day.

   o This would also enable any peak fares charged in off-peak periods to be identified automatically.

      - However, since drivers do not handle cash, there would be no incentive for them to charge peak fares during off-peak periods.

	Low Estimate	High Estimate
Estimated cost	$100 per vehicle	$200 per vehicle
Fleet size	2250	2250
Total cost	$225000	$450000

3. For rail, existing VISIFARE equipment would be retained and the keys reassigned similarly as for bus.

   o A visual display at the ticket agent booth or station entrance would be illuminated during off-peak periods which would indicate when off-peak fares were in force.

      - The system would therefore depend on riders ensuring they had paid the correct fare.

- The visual displays would need to be blinked in some way to the central control room to ensure accurate change-over times.

	Low	High
Estimated cost per display (incl. control)	$1000	$2000
No. of display units (app one per entrance)	180	180
Total cost	$180000	$360000

4. For both bus and rail, it has been assumed there would be no change in operating costs.

   TOTAL COST OF OPTION (Thousands of dollars) 405000 to 810000

OPTION 2(a) - RAIL ZONAL

1. The estimates of capital costs are shown in the following pages of this appendix.

2. Operating costs assumed that a team of ticket inspectors would be required but that there would be sufficient savings in station agents made available through the introduction of open stations and the installation of ticket vending machines at all stations, to avoid any net increase in costs.

3. Operating costs associated with fare equipment maintenance assumed a nominal 5 percent of the capital costs per year, i.e., this represented the increase to the existing maintenance costs.

OPTION 2(b) - SYSTEM ZONAL

1. Capital costs were those as for Option 2(a) with the addition of costs associated with equipping the bus fleet with ticket vending machines and fare validators.

	Low	High
Fleet size	2250	2250
Cost per vending machine	$3000	$4000
Cost per validator	$1000	$2000
total cost (million)	$9.00	$13.5

2. Operating costs assumed a team of 50 ticket inspectors would be required to enforce the distance based fares on bus.

	Low	High
Cost per inspector (pa)	$50000	$50000
No. of inspectors	40	60
Total cost (pa)	$2.00	$3.00

OPTION 2(c) - GRADUATED RAIL

1. Capital costs are shown in subsequent pages to this appendix.

2. Additional maintenance costs to those associated with the existing fare controls assumed a nominal 5 percent of the equipment costs.

3. No change in staff level was assumed.

OPTION 3 - BUS/RAIL FARES

1. The only increase in cost for this option would be associated with the introduction of differential bus and rail monthly passes if this proved absolutely necessary.

2. It was assumed that the number of passes would remain unchanged and that the extra costs would arise from additional administration.

   - It was assumed that administration costs would increase by two thirds.

3. Administration costs were based on earlier CTA work as described in Option 4 below.

   TOTAL COST OF OPTION (thousands of dollars) $376,992

OPTION 4 - MAXIMUM PREPAYMENT

1. Pass take-up would increase to 200,000 in circulation at any one time.

2. Pass types would be distributed as follows:

		Total pa.
Weeklies	50%	5200000
Monthlies	25%	600000
Quarterlies	25%	200000
Total passes	100%	6000000

3. Costs have been based on the CTA report entitled "ANALYSIS OF WEEKLY AND BIWEEKLY PASS ALTERNATIVE IMPACTS" prepared by Operations Planning and Treasury Departments in October, 1985.

   - This study examined the option to introduce both weekly and monthly passes which would imply that the total number of passes required to be produced based on the average of the range estimated to be sold was around 5 million.

     - Since this option assumes 6 million passes per year, costs from the study were up-lifted by 20 percent. The costs were also increased by 5% to allow for inflation.

	Low	High
Cost of Weekly, Monthly, Quarterly Passes($M)	2.84	3.71

4. The option also assumed that some prepaid tickets would be made available from vending machines. This would be limited to daily tickets.

	Low	High
Cost of vending machine	$1500	$2500
No. of vending machines	500	500
Total cost	$750000	$1250000
Annual Cost	$176900	$295000

APPENDIX D OPTION COSTS

SUMMARY OF OPTION COSTS

OPTION	EST. RANGE	CAPITAL COSTS $M	REVENUE EQUIVALENT OF CAPITAL $M.PA	OPERATING REVENUE COSTS $M PA.	TOTAL ANNUAL COST $M PA.	COST PER FARE Cents
1.PEAK/OFF-PEAK	low	.41	.03	.00	.03	.01
	high	.81	.07	.00	.07	.02
2A.RAIL ZONAL	low	40.68	3.37	2.03	5.41	1.73
	high	55.44	4.60	2.77	7.37	2.35
2B.SYSTEM ZONAL	low	49.68	4.12	4.98	9.10	2.91
	high	68.94	5.72	5.95	11.66	3.73
2C.RAIL GRADUATED	low	67.28	5.58	3.36	8.94	2.86
	high	92.08	7.64	4.60	12.24	3.91
3.BUS/RAIL	low			.38	.38	.12
	high			.38	.38	.12
4.MAXIMUM PREPAYMENT	low	.75	.18	2.84	3.02	.96
	high	1.25	.29	3.71	4.00	1.28

Notes: Capital costs are represented as their revenue equivalent assuming an asset life of 25 years and a discount rate of 7 percent with the exception of Option 4 which assumed 5 years.

APPENDIX D COST ESTIMATES FOR OPTIONS 2A AND 2C

LOW ESTIMATE

Station classification

At grade old(Harlem Lake)	1
Elevated	2
New surface(Cumberland)	3
Subsurface	4
Loop elevated	5

List of assumptions	Unit	Option 2A	Option 2C
Capacity of gate (5 mins flowrate)	125		
Tidal flow ratio	1.2		
Total No.of open stations		28	
Total number of gates		531	615
Total cost of gates($)	25000	13275000	15375000
Capacity of ticket v/machine(5mins)	100		
No.of ticket v/machines reqrd.		276	385
Cost of ticket v/machine	25000	6900000	9625000
Cost of TVM installation	10000	2760000	3850000
Cost of Add-fare m/c	25000		8650000
Demolition cost (old) class 1 & 2	4000		
Demoltion cost(new) class 3	8000		
Demolition cost(sub) class 4	17000		
Demolition cost(El) class 5	8000		
Total demolition costs		1164333.	1164333.
Cost of agents booth	50000	3350000	
Cost of installing 3 gates elevated	8000		
Cost of installing 3 gates at grade	5000		
Station architectural modifications	20000	240000	240000
Allowance for difficult cases			10000000
Total cost of gate installation($M)		914333	1300000
Cost of station computers	20000	2300000	2860000
Cost of central computer	2e6	2000000	2000000
Software		1000000	1000000
Total equipment and modification cost		33.90	56.06
Engineering & design(20%)	20	6.78	11.21
Total project costs($ millions)		40.68	67.28

APPENDIX D COST ESTIMATES FOR OPTIONS 2A AND 2C

HIGH ESTIMATE

Station classification

At grade old(Harlem Lake)	1
Elevated	2
New surface(Cumberland)	3
Subsurface	4
Loop elevated	5

List of assumptions	Unit	Option 2A	Option 2C
Capacity of gate (5 mins flowrate)	100		
Tidal flow ratio	1.5		
Total No.of open stations		28	
Total number of gates		540	624
Total cost of gates($)	35000	18900000	21840000
Capacity of ticket v/machine(5mins)	80		
No.of ticket v/machines reqrd.		315	469
Cost of ticket v/machine	35000	11025000	16415000
Cost of TVM installation	15000	4725000	7035000
Cost of Add-fare m/c	35000		12110000
Demolition cost (old) class 1 & 2	4000		
Demoltion cost(new) class 3	12000		
Demolition cost(sub) class 4	17000		
Demolition cost(El) class 5	8000		
Total demolition costs		1316333.	1316333.
Cost of agents booth	50000	3350000	
Cost of installing 3 gates elevated	12000		
Cost of installing 3 gates at grade	7000		
Station archictectural modifications	20000	240000	240000
Allowance for difficult cases			10000000
Total cost of gate installation($M)		1344667	1917667
Cost of station computers	20000	2300000	2860000
Cost of central computer	2e6	2000000	2000000
Software		1000000	1000000
Total equipment and modification cost		46.20	76.73
Engineering & design(20%)	20	9.24	15.35
Total project costs($ millions)		55.44	92.08

APPENDIX D LIST OF STATIONS

STATCOST		RTI.CAL	OPEN	TYPE	max 15min traffic	Op.2C No.of gates req.	Op.2A No.of gates req.	Op.2C No.of vmc. req	Op.2A No.of vmc. req.
O'HARE	0107	O'HARE	0	3	375	3	3	4	3
O'HARE	0108	RIVER ROAD	0	3	235	3	3	3	2
O'HARE	0109	CUMBERLAND	0	3	330	3	3	4	2
O'HARE	0110	HARLEM	0	3	300	3	3	3	2
O'HARE	0111	JEFFERSON PARK	0	3	600	3	3	6	4
O'HARE	0112	MONTROSE	0	3	115	3	3	2	1
O'HARE	0113	IRVING PARK	0	3	220	3	3	3	2
O'HARE	0114	IRVING PARK-PULASKI	0	3	45	3	3	1	1
O'HARE	0115	ADDISON	0	3	180	3	3	2	2
O'HARE	0116	BELMONT-KIMBALL	0	3	340	3	3	4	3
O'HARE	0117	LOGAN SQUARE-KEDZIE	0	3	205	3	3	3	2
O'HARE	0118	LOGAN SQUARE-SPAULDING	0	3	180	3	3	2	2
O'HARE	0120	CALIFORNIA	0	3	115	3	3	2	1
O'HARE	0121	WESTERN	0	3	125	3	3	2	1
O'HARE	0122	DAMEN	0	3	175	3	3	2	2
O'HARE	0123	DIVISION	0	4	240	3	3	3	2
O'HARE	0124	CHICAGO	0	4	75	3	3	1	1
O'HARE	0125	GRAND	0	4	55	3	3	1	1
CONGR	0208	CLINTON	0	9	175	3	3	2	2
CONGR	0209	HALSTED	0	3	85	3	3	1	1
CONGR	0210	PEORIA	0	3	305	3	3	4	2
CONGR	0212	RACINE	0	3	115	3	3	2	1
CONGR	0215	MEDICAL CENTER OGDEN	0	3	125	3	3	2	1
CONGR	0217	WESTERN	0	3	50	3	3	1	1
CONGR	0219	KEDZIE	0	3	50	3	3	1	1
CONGR	0220	HOMAN	0	3	65	3	3	1	1
CONGR	0221	PULASKI	0	3	85	3	3	1	1
CONGR	0224	CICERO	0	3	85	3	3	1	1
CONGR	0227	AUSTIN	0	3	95	3	3	1	1
CONGR	0228	LOMBARD	0	3	30	3	3	1	1
CONGR	0230	OAK PARK	0	3	115	3	3	2	1
CONGR	0231	HARLEM	0	3	70	3	3	1	1
CONGR	0233	DESPLAINES	0	3	285	3	3	3	2
DOUGL	0334	POLK	0	1	215	3	3	3	2
DOUGL	0335	18TH	1	1	90	3	0	1	1
DOUGL	0336	HOYNE	1	2	60	3	0	1	1
DOUGL	0337	WESTERN	1	1	70	3	0	1	1
DOUGL	0338	CALIFORNIA	1	1	100	3	0	1	1
DOUGL	0339	KEDZIE	1	1	65	3	0	1	1
DOUGL	0340	CENTRAL PARK	1	2	75	3	0	1	1
DOUGL	0341	PULASKI	1	2	85	3	0	1	1
DOUGL	0342	KILDARE	1	2	45	3	0	1	1
DOUGL	0344	CICERO	1	1	115	3	0	2	1
DOUGL	0346	LARAMIE	1	2	60	3	0	1	1
DOUGL	0347	54TH AVENUE	1	2	165	3	0	2	1

LAKE	0448 CLINTON	1	2	175	3	0	2	2
LAKE	0449 HALSTED	1	2	30	3	0	1	1
		0	2	45	3	3	1	1
LAKE	0450 ASHLAND	1	2	25	3	0	1	1
		0	2	40	3	3	1	1
LAKE	0451 CALIFORNIA	1	2	25	3	0	1	1
		0	2	35	3	3	1	1
LAKE	0452 KEDZIE	1	2	30	3	0	1	1
		0	2	45	3	3	1	1
LAKE	0453 HOMAN	1	2	40	3	0	1	1
		0	2	40	3	3	1	1
LAKE	0454 PULASKI	1	2	90	3	0	1	1
		0	2	90	3	3	1	1
LAKE	0455 CICERO	1	2	135	3	0	2	1
LAKE	0456 LARAMIE	1	2	120	3	0	2	1
		0	2	120	3	3	2	1
LAKE	0457 CENTRAL	0	1	175	3	3	2	2
LAKE	0461 AUSTIN	0	1	105	3	3	2	1
LAKE	0462 RIDGELAND	0	1	115	3	3	2	1
LAKE	0464 OAK PARK	0	1	85	3	3	1	1
LAKE	0465 MARION	0	1	85	3	3	1	1
LAKE	0466 HARLEM	0	1	195	3	3	2	2
EVANST	0567 LINDEN	1	1	150	3	0	2	1
EVANST	0569 CENTRAL	1	1	75	3	0	1	1
EVANST	0570 NOYES	1	2	45	3	0	1	1
EVANST	0571 FOSTER	1	2	55	3	0	1	1
EVANST	0572 DAVIS	1	1	250	3	0	3	2
EVANST	0573 DEMPSTER	1	1	60	3	0	1	1
EVANST	0574 MAIN	1	1	120	3	0	2	1
EVANST	0575 SOUTH BOULEVARD	1	1	65	3	0	1	1
SKOKIE	0676 DEMPSTER	0	1	195	3	3	2	2
RAVENS	0777 MERCHANDISE MART	0	5	250	3	3	3	2
RAVENS	0780 CHICAGO & FRANKLIN	0	5	110	3	3	2	1
RAVENS	0781 SEDGWICK	0	1	70	3	3	1	1
RAVENS	0782 ARMITAGE	0	1	160	3	3	2	1
RAVENS	0783 DIVERSEY	0	1	160	3	3	2	1
RAVENS	0784 WELLINGTON	0	1	75	3	3	1	1
RAVENS	0785 SOUTHPORT	0	1	90	3	3	1	1
RAVENS	0786 PAULINA & LINCOLN	0	1	35	3	3	1	1
RAVENS	0787 ADDISON & LINCOLN	0	1	85	3	3	1	1
RAVENS	0788 IRVING PARK	0	1	110	3	3	2	1
RAVENS	0789 MONTROSE	0	1	75	3	3	1	1
RAVENS	0790 DAMEN	0	1	90	3	3	1	1
RAVENS	0791 WESTERN	0	1	200	3	3	2	2
RAVENS	0792 ROCKWELL	0	1	50	3	3	1	1
RAVENS	0793 FRANCISCO	0	1	45	3	3	1	1
RAVENS	0794 KEDZIE	0	1	75	3	3	1	1
RAVENS	0796 KIMBALL	0	1	250	3	3	3	2

N MAIN	0801 HOWARD	0	1	515	3	3	6	4
N MAIN	0802 JARVIS	0	1	85	3	3	1	1
N MAIN	0803 LUNT	0	1	65	3	3	1	1
N MAIN	0804 MORSE-ROGERS PARK	0	1	295	3	3	3	2
N MAIN	0805 LOYOLA	0	1	370	3	3	4	3
N MAIN	0807 GRANVILLE	0	1	175	3	3	2	2
N MAIN	0808 THORNDALE	0	1	150	3	3	2	1
N MAIN	0809 BRYN MAWR	0	1	320	3	3	4	2
N MAIN	0810 BERWYN	0	1	140	3	3	2	1
N MAIN	0811 ARGYLE	0	1	130	3	3	2	1
N MAIN	0812 LAWRENCE	0	1	130	3	3	2	1
N MAIN	0813 WILSON-UPTOWN	0	1	210	3	3	3	2
		0	1	160	3	3	2	1
N MAIN	0814 SHERIDAN	0	1	195	3	3	2	2
N MAIN	0815 ADDISON	0	1	200	3	3	2	2
N MAIN	0816 BELMONT	0	1	480	3	3	5	3
N MAIN	0817 FULLERTON	0	1	505	3	3	6	4
N MAIN	0818 NORTH & CLYBOURN	0	1	100	3	3	1	1
N MAIN	0819 CLARK & DIVISION	0	1	345	3	3	4	3
N MAIN	0820 CHICAGO & STATE	0	4	685	3	3	7	5
N MAIN	0821 GRAND & STATE	0	4	305	3	3	4	2
S MAIN	0916 HARRISON	0	4	70	3	3	1	1
S MAIN	0917 ROOSEVELT	0	4	225	3	3	3	2
S MAIN	0920 35TH - TECH	0	1	235	3	3	3	2
S MAIN	0921 INDIANA	0	1	70	3	3	1	1
S MAIN		0	1		3	3	0	0
S MAIN	0922 43RD STREET	0	1	120	3	3	2	1
S MAIN	0924 47TH STREET	0	1	190	3	3	2	2
S MAIN	0927 51ST STREET	0	1	160	3	3	2	1
S MAIN	0928 GARFIELD	0	1	115	3	3	2	1
S MAIN	0929 58TH	0	2	45	3	3	1	1
S MAIN	0930 61ST	0	1	70	3	3	1	1
S MAIN		0	1		3	3	0	0
S MAIN	0931 KING DRIVE	0	2	105	3	3	2	1
S MAIN	0932 COTTAGE GROVE	0	2	145	3	3	2	1
S MAIN	0933 UNIVERSITY	0	2	145	3	3	2	1
S MAIN	1039 WENTWORTH	0	2	30	3	3	1	1
S MAIN	1040 HARVARD	0	2	45	3	3	1	1
S MAIN	1041 HALSTED	0	1	120	3	3	2	1
S MAIN	1042 RACINE	0	1	85	3	3	1	1
S MAIN	1045 ASHLAND	0	1	280	3	3	3	2

LOOP	1145 LASALLE & VAN BUREN-INNER	0	5	50	3	3	1	1
LOOP	1146 LASALLE & VAN BUREN-OUTER	0	5	170	3	3	2	2
LOOP	1150 ADAMS & WABASH-MEZZANINE	0	5	730	8	8	8	5
LOOP	1151 MADISON & WABASH-MEZZANINE	0	5	445	4	4	5	3
LOOP	1153 RANDOLPH & WABASH-INNER	0	5	385	4	4	4	3
LOOP	1154 RANDOLPH & WABASH-OUTER	0	5	200	3	3	2	2
LOOP	1155 STATE & LAKE-INNER	0	5	340	4	4	4	3
LOOP	1156 STATE & LAKE-OUTER	0	5	275	4	4	3	2
LOOP	1157 CLARK & LAKE-INNER	0	5		3	3	0	0
LOOP	1158 CLARK & LAKE-OUTER	0	5		3	3	0	0
LOOP	1159 RANDOLPH & WELLS-INNER	0	5	30	3	3	1	1
LOOP	1160 RANDOLPH & WELLS-OUTER	0	5	60	3	3	1	1
LOOP	1161 MADISON & WELLS-INNER	0	5	65	3	3	1	1
LOOP	1162 MADISON & WELLS-OUTER	0	5	185	3	3	2	2
LOOP	QUINCY/WELLS INNER	0	5	45	3	3	1	1
LOOP	QUINCY/WELLS OUTER	0	5	165	3	3	2	1
DEARB	1279 LAKE TRANSFER - WELLS	0	5	300	3	3	3	2
DEARB	1281 RANDOLPH - WASHINGTON	0	5	850	4	4	9	6
DEARB	1282 WASHINGTON - MADISON	0	5	135	3	3	2	1
DEARB	1283 MADISON - MONROE	0	5	395	3	3	4	3
DEARB	1284 MONROE - ADAMS	0	5	195	3	3	2	2
DEARB	1285 ADAMS - JACKSON	0	5	440	3	3	5	3
DEARB	1286 JACKSON - VAN BUREN	0	5	250	3	3	3	2
DEARB	1287 LASALLE-CONGRESS	0	5	185	3	3	2	2
STATE	1369 LAKE-RANDOLPH	0	5	405	4	4	5	3
STATE	1370 RANDOLPH-WASHINGTON	0	5	455	4	4	5	3
STATE	1371 WASHINGTON-MADISON	0	5	225	3	3	3	2
STATE	1372 MADISON-MONROE	0	5	335	3	3	4	3
STATE	1373 MONROE-ADAMS	0	5	100	3	3	1	1
STATE	1374 ADAMS-JACKSON	0	5	505	4	4	6	4
STATE	1375 JACKSON-VAN BUREN	0	5	165	3	3	2	1
DAN RY	1401 95TH	0	3	1400	7	7	14	9
DAN RY	1402 87TH	0	3	345	3	3	4	3
DAN RY	1403 79TH	0	3	475	3	3	5	3
DAN RY	1404 69TH	0	3	415	3	3	5	3
DAN RY	1405 63RD	0	3	160	3	3	2	1
DAN RY	1406 GARFIELD-WEST	0	3	180	3	3	2	2
DAN RY	1407 47TH-WEST	0	3	90	3	3	1	1
DAN RY	1408 SOX-35TH	0	3	165	3	3	2	1
DAN RY	1410 CERMAK-WEST	0	3	110	3	3	2	
	Total auxiliary entrances	13			39	39		
	Total auxiliary exits	34			34	34		
	Total terminal stations	12						
	Ototal stations	143			615	531	385	276
	open stations	28						

LOOP	1145 LASALLE & VAN BUREN-INNER	0	5	50	3	3	1	1
LOOP	1146 LASALLE & VAN BUREN-OUTER	0	5	170	3	3	2	2
LOOP	1150 ADAMS & WABASH-MEZZANINE	0	5	730	8	8	8	5
LOOP	1151 MADISON & WABASH-MEZZANINE	0	5	445	5	5	5	3
LOOP	1153 RANDOLPH & WABASH-INNER	0	5	385	5	5	4	3
LOOP	1154 RANDOLPH & WABASH-OUTER	0	5	200	5	5	2	2
LOOP	1155 STATE & LAKE-INNER	0	5	340	5	5	4	3
LOOP	1156 STATE & LAKE-OUTER	0	5	275	5	5	3	2
LOOP	1157 CLARK & LAKE-INNER	0	5		5	5	0	0
LOOP	1158 CLARK & LAKE-OUTER	0	5		5	5	0	0
LOOP	1159 RANDOLPH & WELLS-INNER	0	5	30	5	5	1	1
LOOP	1160 RANDOLPH & WELLS-OUTER	0	5	60	5	5	1	1
LOOP	1161 MADISON & WELLS-INNER	0	5	65	5	5	1	1
LOOP	1162 MADISON & WELLS-OUTER	0	5	185	5	5	2	2
LOOP	QUINCY/WELLS INNER	0	5	45	5	5	1	1
LOOP	QUINCY/WELLS OUTER	0	5	165	5	5	2	1
DEARB	1279 LAKE TRANSFER - WELLS	0	4	300	5	5	3	2
DEARB	1281 RANDOLPH - WASHINGTON	0	4	850	5	5	9	6
DEARB	1282 WASHINGTON - MADISON	0	4	135	5	5	2	1
DEARB	1283 MADISON - MONROE	0	4	395	5	5	4	3
DEARB	1284 MONROE - ADAMS	0	4	195	5	5	2	2
DEARB	1285 ADAMS - JACKSON	0	4	440	5	5	5	3
DEARB	1286 JACKSON - VAN BUREN	0	4	250	5	5	3	2
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STATE	1369 LAKE-RANDOLPH	0	4	405	5	5	5	3
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STATE	1371 WASHINGTON-MADISON	0	4	225	5	5	3	2
STATE	1372 MADISON-MONROE	0	4	335	5	5	4	3
STATE	1373 MONROE-ADAMS	0	4	100	5	5	1	1
STATE	1374 ADAMS-JACKSON	0	4	505	5	5	6	4
STATE	1375 JACKSON-VAN BUREN	0	4	165	5	5	2	1
DAN RY	1401 95TH	0	3	1400	7	7	14	9
DAN RY	1402 87TH	0	3	345	3	3	4	3
DAN RY	1403 79TH	0	3	475	3	3	5	3
DAN RY	1404 69TH	0	3	415	3	3	5	3
DAN RY	1405 63RD	0	3	160	3	3	2	1
DAN RY	1406 GARFIELD-WEST	0	3	180	3	3	2	2
DAN RY	1407 47TH-WEST	0	3	90	3	3	1	1
DAN RY	1408 SOX-35TH	0	3	165	3	3	2	1
DAN RY	1410 CERMAK-WEST	0	3	110	3	3	2	
	Total auxiliary entrances	13			39	39		
	Total auxiliary exits	34			34	34		
	Total terminal stations	12						
	0total stations	143			663	579	385	276

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